

User and maintenance manual for generating sets



R340U

33504081101NE_0_1

CALIFORNIA
Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

If this product contains a gasoline engine



WARNING

The engine from this product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm

The state of California requires the above two warnings.

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1. Preface

1.1. General recommendations




Thank you for choosing an electrical generating set from our company.

This manual has been designed to help you operate and maintain your electrical generating set correctly.

The information contained in this manual is taken from technical data available at the time of print. In line with our policy of continually improving the quality of our products, this information may be amended without warning.

Read the safety instructions attentively in order to prevent any accidents, faults or damage. These instructions must always be followed.

You are likely to encounter several warning symbols in this manual.

| | |
|---|---|
|  Danger | This symbol indicates an immediate danger to human health and life in case of exposure. Failure to follow the corresponding advice entails serious consequences for human health and life in case of exposure. |
|  Warning | This symbol draws attention to the potential risks to human health and life in case of exposure. Failure to follow the corresponding advice entails serious consequences for human health and life in case of exposure. |
|  Important | This symbol indicates a dangerous situation if the warning is not heeded. Failure to follow the corresponding advice risks resulting in minor injury of personnel or damage to any other object in case of exposure. |

In order to obtain optimum efficiency and the longest possible life for the electrical generating sets, maintenance operations must be carried out according to the periods indicated in the attached preventative maintenance tables. If the electrical generating set is used under dusty or unfavourable conditions, some of these periods will be shorter.


Ensure that all repairs and adjustments are carried out by personnel who have received appropriate training. Dealers have this qualification, and can answer all of your questions. They can also supply you with spare parts and other services.

The left and right sides can be seen from the back of the electrical generating set (the radiator is at the front).

Our electrical generating sets have been designed so that damaged or worn parts can be replaced by new or reconditioned parts thereby reducing the out of action period to a minimum.

For any replacement of parts, contact your nearest dealer for our company who will have the necessary equipment and can offer properly trained and informed staff to carry out maintenance, parts replacement and even total reconditioning of generating sets.

Contact your local dealer for the available repair manuals and to make the necessary arrangements for training personnel in implementation and maintenance.

| | |
|---|---|
|  | Some user and maintenance manuals for the engines fitted to generating sets cover control units and include the start-up and shutdown procedures for the engines. As the generating sets are fitted with control units that are specific to the generating sets, only the information that appears in the documentation for the generating sets' control units should be taken into consideration. |
| Important | In addition, according to the manufacturing criteria of the generating sets, some engines may be fitted with specific electrical wiring different to that described in the engine documentation. |

1.2. Pictograms and their meanings

Safety notices are clearly mounted on the equipment to draw the operator's or maintenance technician's attention to the potential dangers and explain the action to be taken in the interest of safety. These notices are reproduced in this publication for ease of identification by the operator.

Replace any notice that is missing or illegible.














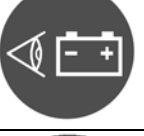





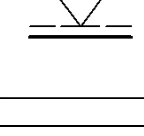



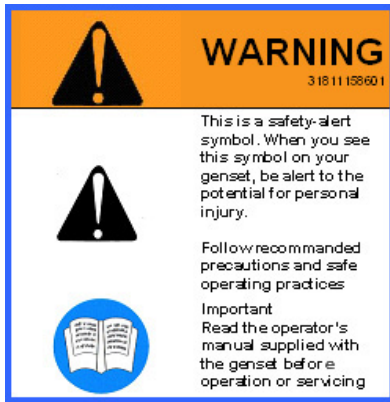
| | | | | | |
|---|---|---|--|---|--|
|  | Caution: danger |  | Publications delivered with the generating set must be referred to |  | Caution: risk of explosion |
|  | Caution: risk of electric shock |  | Protective clothing must be worn |  | Naked flames and unprotected lights prohibited. No smoking |
|  | Caution: toxic materials |  | Eyes and ears must be protected |  | Entry prohibited to non-authorised persons |
|  | Caution: pressurised fluids |  | Periodic maintenance must be carried out |  | Jet washing prohibited |
|  | Caution: high temperature, risk of burns |  | Battery level must be checked |  | Earth |
|  | Caution: rotating or moving parts (risk of getting caught in the machinery) |  | Lifting point must be used |  | Caution: product corrosive |
|  | Fork pockets for lifting |  | Retention tank level high | | |
|  | |  | |  | |
| ① | | ② | | | |

Figure 1.1 : Pictograms and their meanings



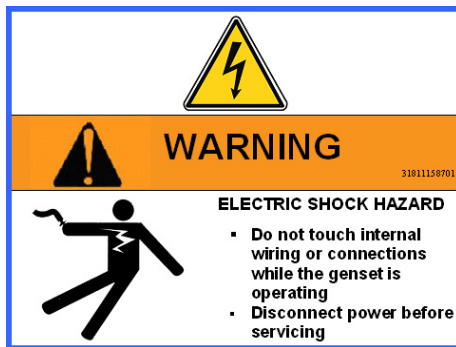
WARNING: DANGER

This symbol warns of a safety hazard. The presence of this symbol indicates a risk of injury.

Observe the safety instructions and precautions for use.

Important:

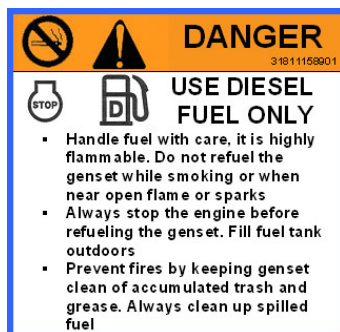
Carefully read the instructions supplied with the generating set before using or servicing the equipment.



WARNING: DANGER

Risk of electrocution

- Do not touch the cables or connections when the generating set is in operation.
- Switch off the generating set for maintenance operations.



DANGER

Use diesel fuel only.

- The fuel is highly flammable, handle with care. Do not smoke near the generating set or expose it to a naked flame or sparks.
- Shut down the generating set engine before filling the fuel tank. Fill with fuel outside.
- To prevent fire risks, clean the generating set regularly. Wipe away any dirt and traces of grease or fuel.



WARNING: DANGER

- The exhaust gases from the engine are toxic and can affect health or even cause death.
- Use the generating set outdoors only, in well ventilated areas, or fit an exhaust extension to discharge the exhaust gases outside.

Figure 1.2 : Pictograms and their meanings



WARNING: DANGER

- Hot coolant can cause serious burns.
- Switch off the engine. Do not remove the filler cap until it is completely cold.
- Do not open the radiator when it is hot.



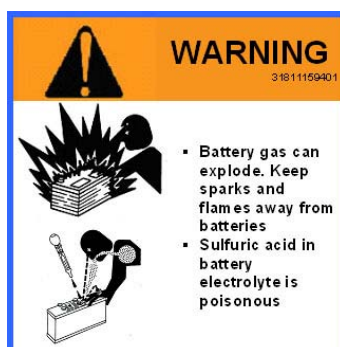
DANGER

- Rotating parts can cause serious injury.
- Do not operate the generating set with the doors open.
- Do not remove the enclosures.
- Shut down the generating set before any maintenance or servicing operation.



DANGER

- Avoid any contact with the exhaust pipes, turbochargers and silencers. Keep flammable materials away from hot parts.
- Wait for the machine to cool down completely before touching it.



WARNING: DANGER

- The gas from the battery electrolyte is explosive. Keep the batteries away from any flames.
- The battery electrolyte (sulphuric acid) is toxic. Risk of poisoning.

Figure 1.2 (continued) : Pictograms and their meanings



WARNING: DANGER

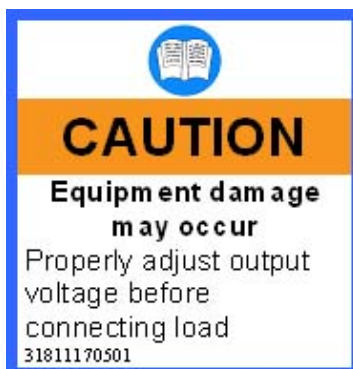
- A poor earth connection can lead to serious injuries or death.
- Always connect the earth terminal of the generating set to an external earth terminal.



WARNING

Voltage selector

This function should be used by qualified persons only.



WARNING

Adjust the output voltage correctly before connecting a load.



WARNING

The voltage selector must not be used when the generating set is operating.

Figure 1.2 (continued) : Pictograms and their meanings

1.3. Instructions and safety regulations

THESE SAFETY GUIDELINES ARE IMPORTANT

If you do not understand or have any questions about any point in this manual, contact your dealer who will explain it to you or give you a demonstration. A list of risks and precautionary measures to take follows. You should also refer to any local and national regulations that apply in accordance with your own jurisdiction.

KEEP THIS MANUAL

This manual contains important instructions which must be followed when installing or carrying out maintenance on a generating set or batteries.

1.3.1 General advice

Use

- ✓ The operating and safety instructions must be made known to operating personnel. They will be regularly updated.
- ✓ Read and understand the manuals provided with the generating set, pump unit or lighting column properly. The manufacturer's instructions must remain at the disposal of technicians, if possible in situ.
- ✓ The facility must be operated under the direct or indirect supervision of a person appointed by the operator, who is familiar with the operation of the facility, and the dangers and drawbacks of the products used or stored in the facility.
- ✓ Do not wear loose clothing, or get close to machines in operation. Note that the fans are not clearly visible when the engine is running.
- ✓ Warn personnel present to keep their distance during operation.
- ✓ Do not run the generating set, pump unit or lighting column without refitting the protective covers and closing all the access doors.
- ✓ Never let a child touch the generating set, pump unit or lighting column, even when shut down.
- ✓ Avoid operating the generating set, pump unit or lighting tower in the presence of animals (disturbance, scares, etc.).
- ✓ Engage the parking brake when the generating set or lighting tower on its trailer is installed on the operating site. When chocking the trailer on a slope; ensure that there is nobody in the path of the trailer.
- ✓ Never start the engine without an air filter or exhaust.
- ✓ Engine with turbocharger: never start the engine without fitting the air filter. The compressor wheel rotating inside the turbocharger may cause serious bodily injury. Foreign objects in the inlet pipe may cause mechanical damage.
- ✓ Engine with air preheating (starting components): never use a starting spray or any other similar starter assistance product. Upon contact with the starting component, an explosion may occur in the inlet tube, causing bodily injury.
- ✓ Do not touch the lighting column lights when they are switched on.

Maintenance

- ✓ Follow the maintenance table and its instructions.
- ✓ Always use tools in good condition which are suited to the work to be done. Ensure you have understood the instructions before beginning any operation.
- ✓ Goggles should be worn when carrying out maintenance operations and watches, bracelets etc. should be removed.
- ✓ Fit only original parts.
- ✓ Disconnect the battery and the pneumatic starter (if fitted) before undertaking any repairs, to prevent the engine from starting accidentally. Fit a panel over the controls to prevent any attempt to start.
- ✓ Only use the correct crankshaft turning techniques for turning the crankshaft manually. Do not try to turn the crankshaft by pulling it or levering the fan. This method may cause serious bodily or material damage, or damage the vanes of the fan, reducing the service life of the fan.
- ✓ Clean off any trace of oil, fuel or coolant using a clean cloth.
- ✓ Do not use a soapy solution containing either chlorine or ammonia, as these two chemicals prevent bubble formation.
- ✓ Never use petrol or other inflammable substances to clean the parts. Use only approved cleaning solvents.
- ✓ Do not use a high pressure cleaner for cleaning the engine and equipment. The radiator, hoses, electrical components, etc. may be damaged.
- ✓ Avoid accidental contact with parts at high temperatures (exhaust manifold, exhaust).
- ✓ Before any maintenance operation on a lighting column light, cut the electrical power supply and wait for the bulbs to cool down.


Consumables

- ✓ Observe regulations in force concerning use of fuel before using your generating set, pump unit or lighting tower.
- ✓ Under no circumstances use seawater or any other corrosive or electrolytic product in the cooling circuit.

Environment

- ✓ The operator must take the necessary measures to comply with the aesthetics of the site of use. The whole site must be maintained in a good state of cleanliness.
- ✓ The premises must be kept clean, and be regularly cleaned so as to avoid accumulation of dangerous materials or pollutants and dust, which could ignite or cause an explosion. The cleaning equipment must be suited to the risks posed by the products and dust.
- ✓ The presence of dangerous or combustible materials inside premises housing combustion devices shall be limited to the operating requirements.
- ✓ Facilities must be operated under the constant supervision of a qualified person, who must regularly check that the safety devices are operating correctly and ensure that the combustion devices have the correct fuel supply.
- ✓ Apart from the combustion devices, it is prohibited to use fire in any form. This restriction must be clearly displayed.
- ✓ Spreading of waste water, sludge and waste is prohibited.
- ✓ The fuels to be used must correspond to those featured in the declaration file and the specifications recommended by the combustion device manufacturer.
- ✓ The fuel is considered to remain in the same physical state as when it is introduced into the combustion chamber.
- ✓ Burning of waste in the open air is prohibited.
- ✓ Always protect your hands when checking for leaks. Pressurised liquids may penetrate body tissue and cause serious damage. Risk of blood contamination.
- ✓ Drain and dispose of engine oil in a specially provided container (fuel distributors can collect your used oil).
- ✓ Except by special agreement, once closed, the gas supply main unit must only be re-opened by the gas distributor. However, the user may access it under certain conditions. Check these for each site.



1.3.2 Risks related to exhaust gases and fuels

| | |
|---|--|
|  | <p>The carbon monoxide present in exhaust gases may cause death if the concentration levels in the air breathed are too high.</p> <p>Always use generating sets, pump units or lighting towers in a well-ventilated place where gases cannot accumulate.</p> <p>In case of indoor use:</p> |
| <p>Danger</p> | <ul style="list-style-type: none"> ✓ Be sure to evacuate exhaust gases outdoors. ✓ Provide appropriate ventilation so that personnel present are not affected. |




- ✓ Observe the local regulations in force for generating sets, pump units or lighting towers, as well as local regulations for use of fuel (petrol, diesel fuel and gas) before using your generating set, pump unit or lighting tower.
- ✓ Fuel filling should be carried out when the engine is off (except for generating sets with an automatic filling system).
- ✓ Engine exhaust gases are toxic: do not run the generating set, pump unit or lighting column in unventilated premises. If installed in a ventilated room, additional requirements for fire and explosion protection must be observed.
- ✓ A leaking burnt gas exhaust may increase the sound level of the generating set, pump unit or lighting column. To check on its efficiency, regularly examine the burnt gas exhaust.
- ✓ Pipes must be replaced as soon as their condition demands it.

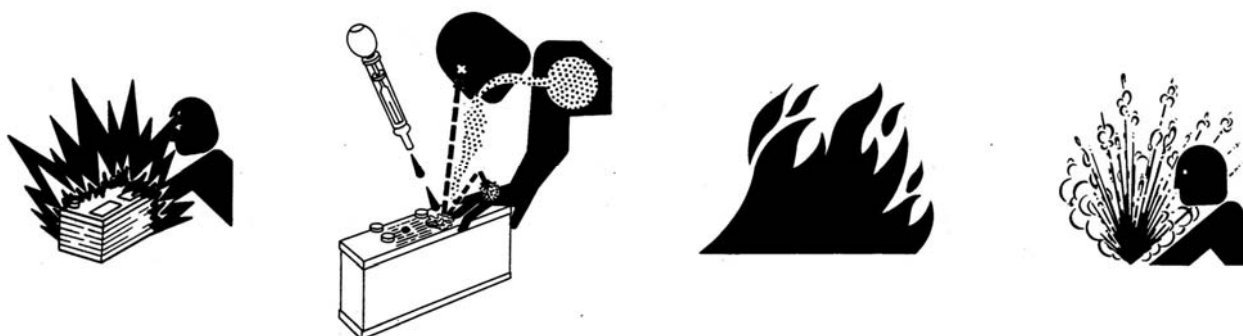
1.3.3 Risks related to toxic products

| | | |
|---|---|--|
|  | <p>The corrosion inhibitor contains alkali. Do not swallow it.</p> <p>This substance should not come into contact with the eyes. In the event of contact with the eyes, rinse immediately with plenty of water for at least 15 minutes.</p> <p>Avoid prolonged or repeated contact with the skin. In the event of contact with the skin, wash thoroughly with water and soap. CONSULT A DOCTOR IMMEDIATELY. KEEP THE PRODUCT OUT OF THE REACH OF CHILDREN.</p> | <p>Glycol is a toxic product and dangerous if absorbed. Avoid all contact with the skin and eyes. Read the instructions on the packaging.</p>  |
| <p>Warning</p> | <p>The anti-rust product is toxic and dangerous if absorbed. Avoid all contact with the skin and eyes. Read the instructions on the packaging.</p> | |

- ✓ Caution: fuels and oils are dangerous to inhale. Ensure proper ventilation, and use a protective mask.
- ✓ Never expose the equipment to liquid splashes or rainfall, and do not place it on wet ground.
- ✓ The battery electrolyte is harmful to skin and especially eyes. If splashes get into eyes, rinse immediately with running water and/or a 10% diluted boric acid solution.
- ✓ Wear protective eyewear and strong base resistant gloves for handling the electrolyte.

1.3.4 Risk of fire, burns and explosion

| | |
|--|---|
|  | <p>The engine should not be operated in environments containing explosive products. As not all of the electrical and mechanical components are shielded, there is a risk of sparks forming.</p> |
| <p>Danger</p> | |



- ✓ Make sure not to create sparks or flames, and not to smoke near the batteries, as the electrolyte gases are highly flammable (especially if the battery is charging). Their acid also poses a risk to the skin, and in particular to the eyes.
- ✓ Never cover the generating set, pump unit or lighting tower with any material during operation or just after shutdown (wait for the engine to cool).
- ✓ Do not touch hot parts such as the exhaust pipe, or put combustible materials on it.
- ✓ Keep all flammable or explosive materials (e.g. petrol, oil, cloth, etc.) out of the way when the set is running.
- ✓ Proper ventilation is required for your generating set, pump unit or lighting column to work properly. Without this ventilation, the engine would very quickly rise to an excessively high temperature, causing accidents or damage to the equipment and to surrounding property.
- ✓ Do not remove the radiator cap if the engine is hot and the coolant is pressurised, due to risks of burns.
- ✓ Depressurise the air, oil and cooling circuits before removing or disconnecting all the fittings, pipes or connected components. Watch out for the possible presence of pressure when disconnecting a device from a pressurised system. Do not try to find pressure leaks by hand. Oil at high pressure can cause bodily damage.
- ✓ Some preservative oils are flammable. Also, some are dangerous to inhale. Ensure proper ventilation. Use a protective mask.
- ✓ Hot oil causes burns. Avoid contact with hot oil. Check that the system is no longer pressurised before carrying out any procedures. Never start or run the engine with the oil filler cap off (oil may splash out).
- ✓ Never coat the generating set, pump unit or lighting column with a thin layer of oil to protect it from rust.
- ✓ Never top up the oil or coolant if the generating set, pump unit or lighting column is running, or if the engine is hot.
- ✓ A generating set can only operate when stationary, and cannot be installed on a vehicle or other mobile equipment, without a prior study taking into account the various specific features of using the generating set.

1.3.5 Risks related to electrical networks

- ✓ The electrical equipment supplied with the generating set complies with standard NF C15.100 (France), or with the standards of the countries in question.
 - ✓ The earth connection must be installed in accordance with the standards in force in each country in question, and with the neutral system sold.
 - ✓ Read the manufacturer's identification plate carefully. The values for voltage, power, current and frequency are shown. Check that these values match the supply use.
 - ✓ Never accidentally touch stripped cables or loose connections.
 - ✓ Never handle a generating set with wet hands or feet.
 - ✓ Maintain electrical wires and connections in good condition. Using equipment in poor condition can lead to electrocution and damage to equipment.
-
- ✓ Always disconnect the power to the equipment or facility (generating set voltage, battery voltage and network voltage) before any operation.
 - ✓ The electrical connections must be made in accordance with current standards and regulations in the country of use.
 - ✓ Do not use faulty, poorly insulated or provisionally connected wires.
 - ✓ Never reverse the positive and negative terminals on batteries when connecting them. This could cause severe damage to the electrical equipment. Follow the wiring diagram supplied by the manufacturer.
 - ✓ The generating set should not be connected to any other power sources, such as the mains supply network. In specific cases where there is to be a connection to existing electrical networks, this must only be installed by a qualified electrician, who should take the operating differences of the equipment into account, according to whether the mains supply network or generating set is being used.
 - ✓ Protection against electric shocks is ensured by an assembly of specific equipment. If this needs to be replaced, it should be by components with identical nominal values and specifications.
 - ✓ If the protective plates (blanking covers) need to be removed to route cables, the protector (blanking cover) must be refitted when the operations are finished.
 - ✓ Due to high mechanical stresses, use only strong flexible wiring with rubber sheathing, compliant with IEC 245-4, or equivalent wiring.

1.3.6 Dangers presented by electric currents (first aid)

First aid

In the event of an electric shock, shut off the power immediately and activate the emergency stop on the generating set or lighting column. If the voltage has not yet been cut off, move the victim out of contact with the live conductor as quickly as possible. Avoid direct contact both with the live conductor and the victim's body. Use a dry plank of wood, dry clothes or other non-conductive materials to move the victim away. The live wire may be cut with an axe. Take great care to avoid the electric arc that will be generated by this.



Begin emergency procedures

Resuscitation

If breathing has stopped, begin artificial respiration at once in the same place the accident took place unless the victim or operator's life could be endangered by this.

In the event of cardiac arrest, carry out cardiac massage.

1.3.7 Risks related to moving the set

To unload the generating sets, pump units or lighting columns from their transport support brackets under optimum safety and efficiency conditions, you must ensure that the following points are observed:

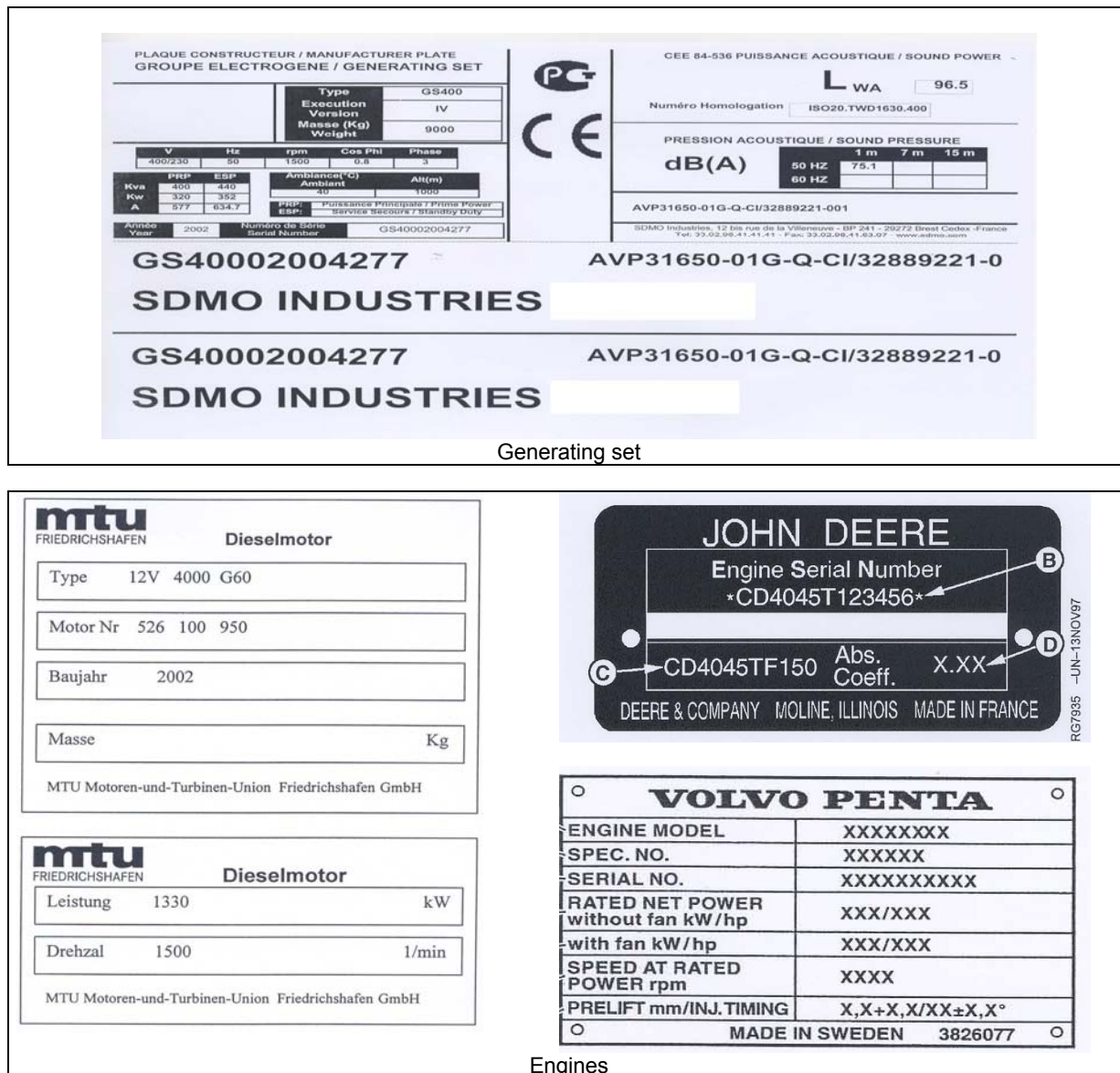
- ✓ The lifting machinery or equipment is suited to the work required, in good condition and with sufficient lifting capacity.
- ✓ The slings are positioned in the rings provided for this operation, the forklift arms are resting fully underneath all of the base frame cross-beams, or the lifting bars are inserted in the apertures provided for this purpose in the base to lift the entire generating set (according to models).
- ✓ For completely safe working conditions and to prevent damage to the components fitted on the upper edge of the set, pump unit or lighting column, the generating set, pump unit or lighting column must be lifted up with an adjustable boom. All the chains and cables must be parallel with each other, and as perpendicular as possible with the upper edge of the generating set, pump unit or lighting column.
- ✓ If other equipment fitted on the generating set, pump unit or lighting column alters its centre of gravity, special lifting devices may be necessary to maintain correct balance and completely safe working conditions.
- ✓ The ground must be able to withstand the load of the generating set, pump unit or lighting column and its lifting machinery without stress (otherwise, put down beams of sufficient strength in a stable configuration).
- ✓ Position the generating set, pump unit or lighting column as close as possible to its place of use or transport, in a clear space with free access.
- ✓ Never perform work on a generating set, pump unit or lighting tower just hanging from a lifting device.

1.4. Identifying sets

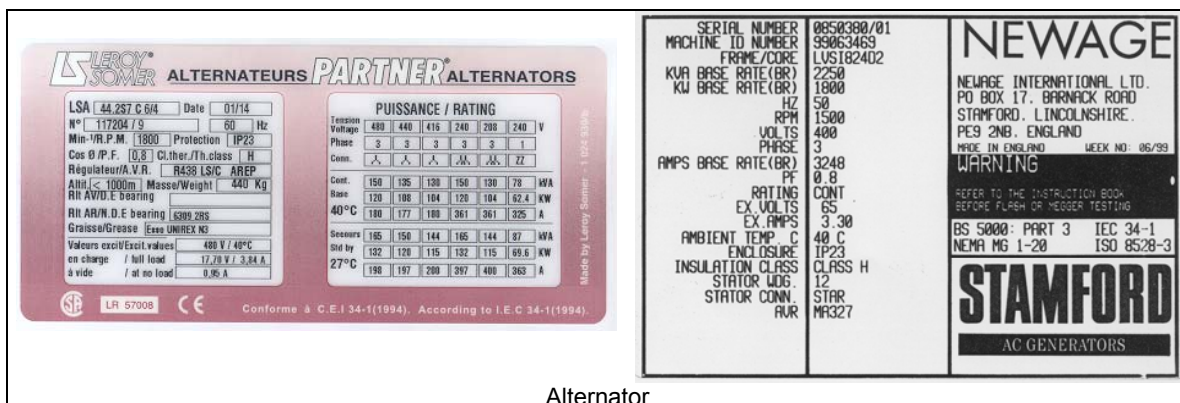
Generating sets and their components are identified by means of identification plates.

The precise rules for identifying each major component (engine, alternator etc.) are set out in each manufacturer's documents contained in this manual.

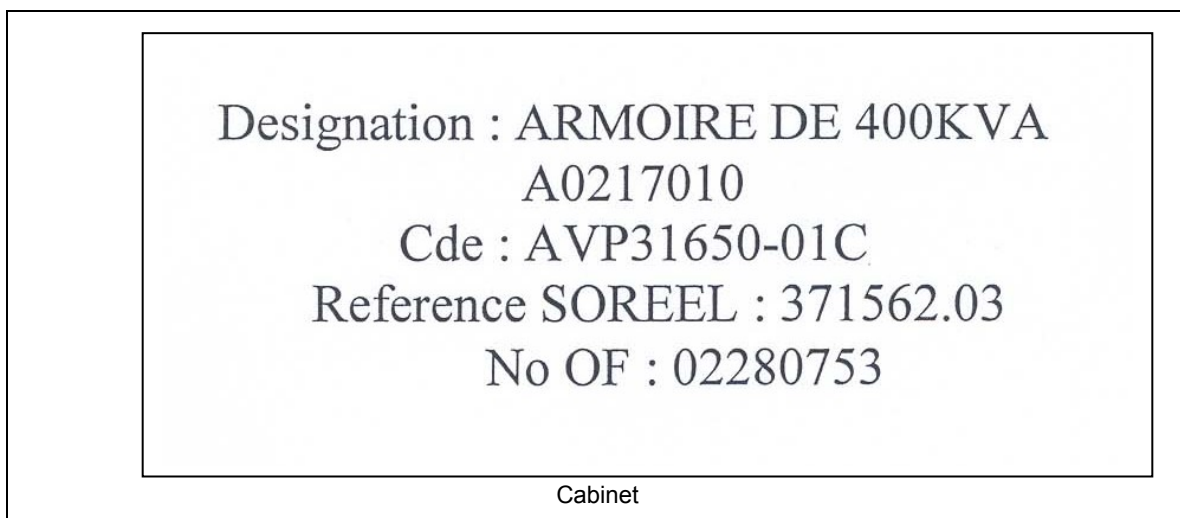
Examples of identification plates



Engines
Figure 1.2 : Examples of identification plates



Alternator



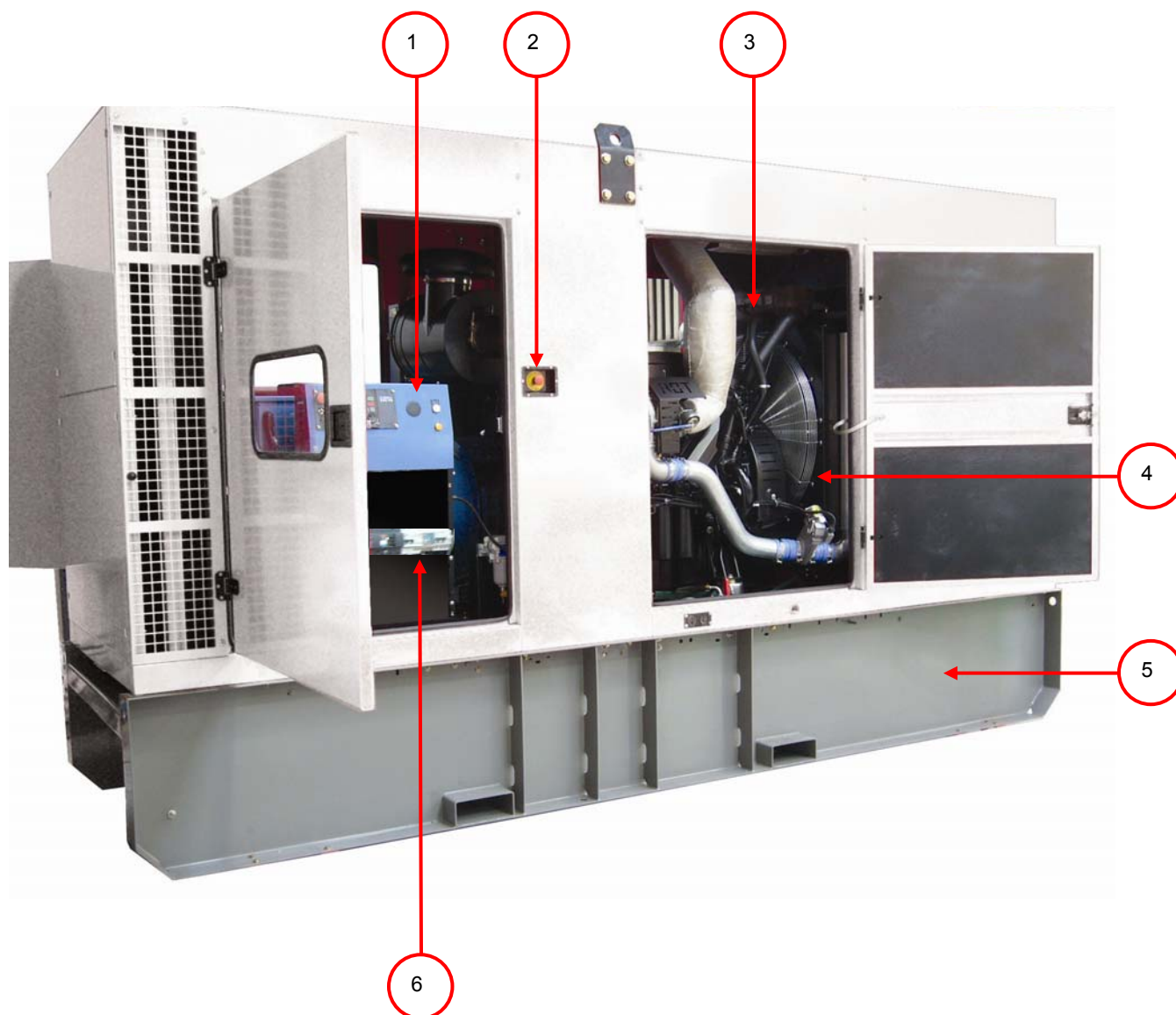
Cabinet

Figure 1.3 : Examples of identification plates

2. General description

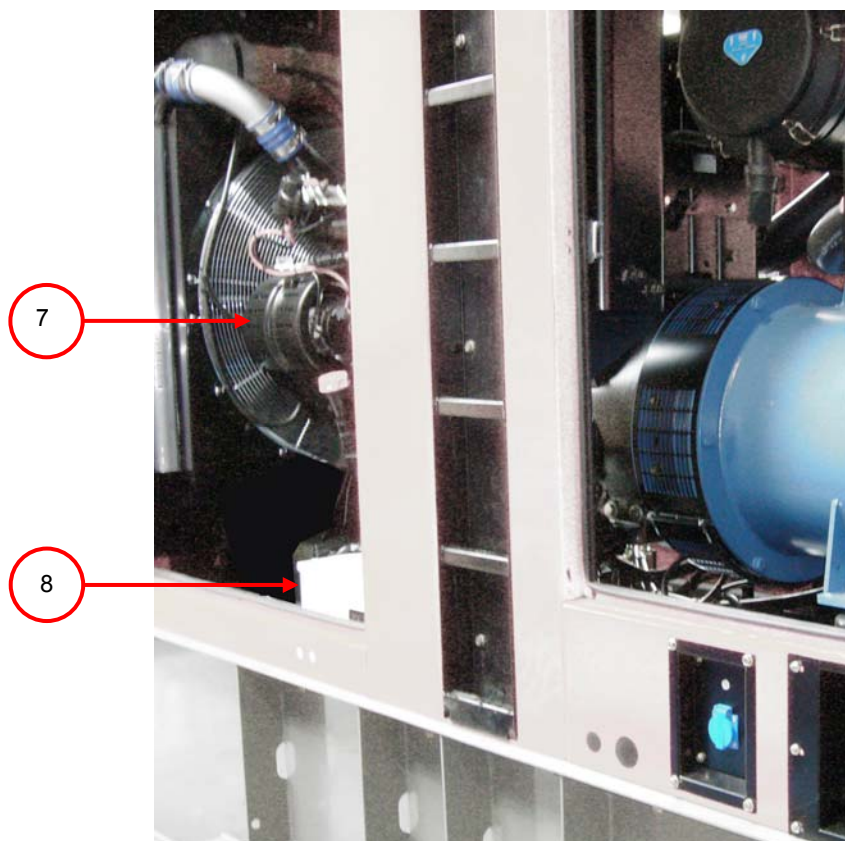
2.1. Description

Overview



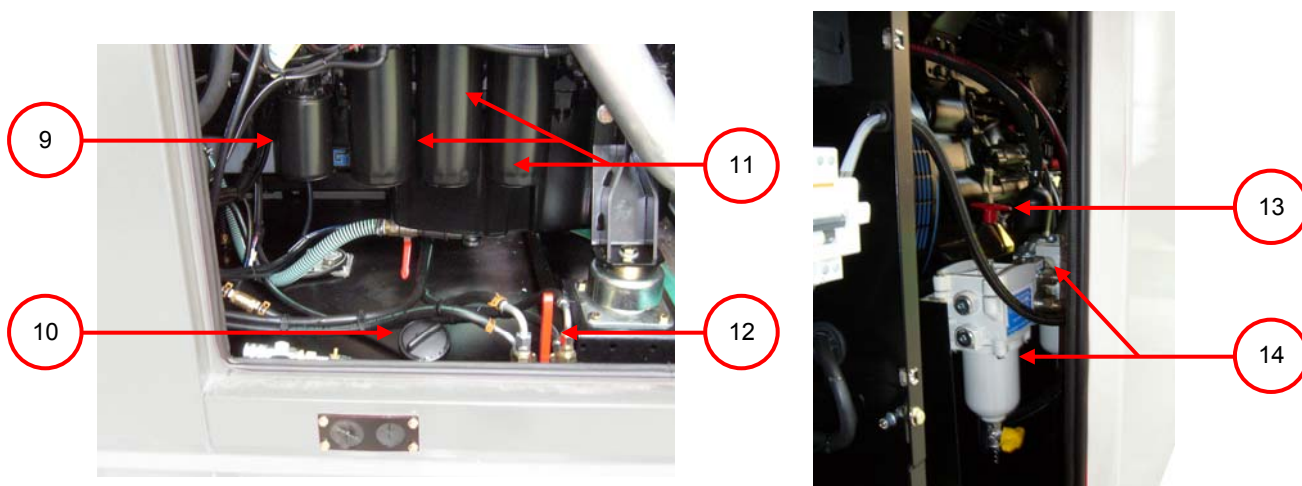
| | | | |
|---|-------------------------|---|--------------------|
| 1 | Control unit | 4 | Protective grilles |
| 2 | External emergency stop | 5 | Chassis |
| 3 | Expansion bottle | 6 | Circuit breakers |

Figure 2.1 : General description of the generating set



| | | | |
|---|---------------------------|---|-------------------|
| 7 | Battery charge alternator | 8 | Starter batteries |
|---|---------------------------|---|-------------------|

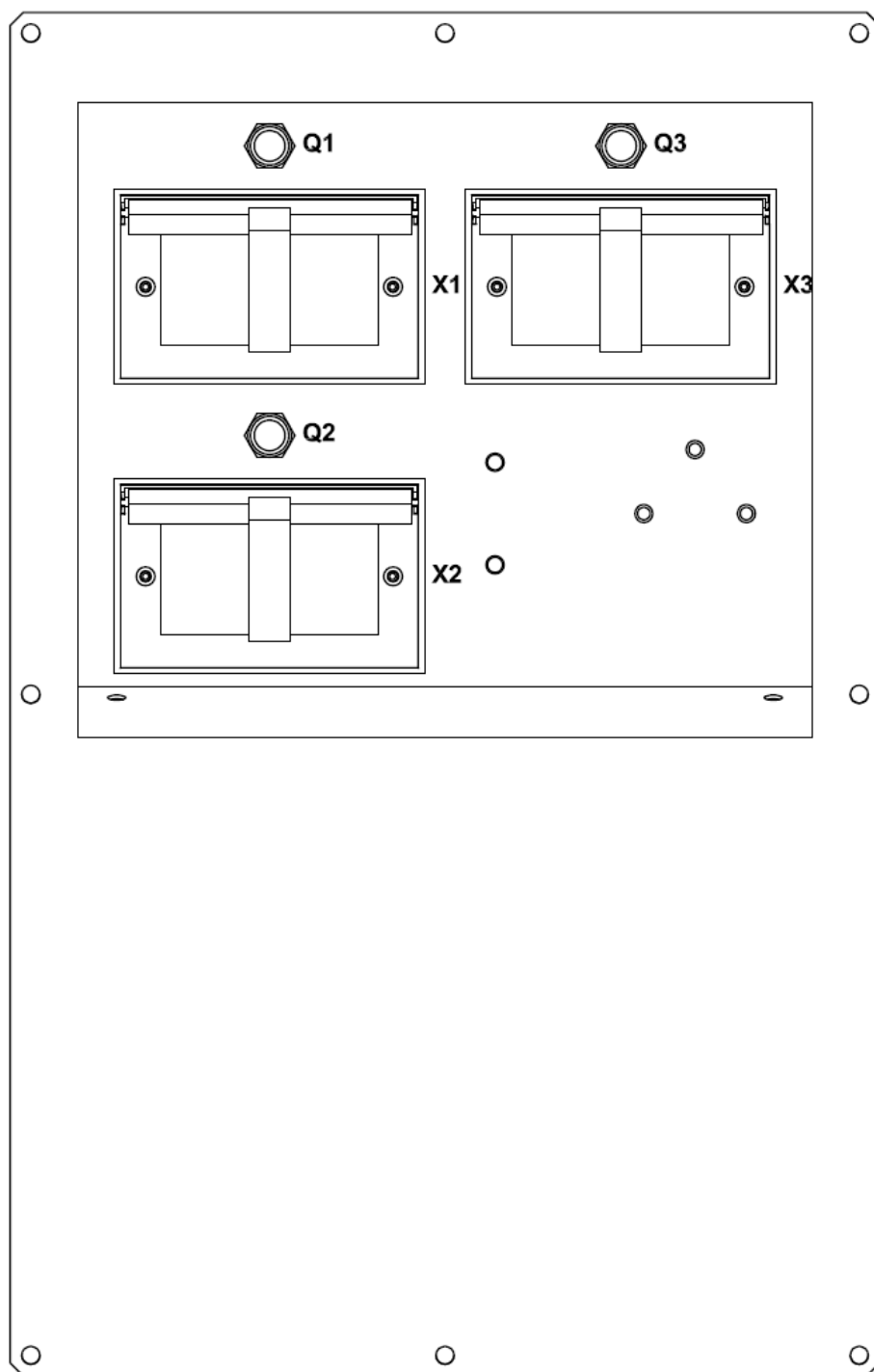
Figure 2.1 (continued): General description of the generating set



| | | | |
|----|-------------------|----|--|
| 9 | Coolant filter | 12 | External fuel supply combined tap (optional) |
| 10 | Filling with fuel | 13 | Circuit breaker |
| 11 | Oil filters | 14 | Interchangeable fuel pre-filters |

Figure 2.1 (continued) : General description of the generating set

Sockets (voltage 208/120V)



X1 SOCKET / PRISE 20A 125V

Q1 CIRCUIT BREAKER / DISJONCTEUR 20A

X2 SOCKET / PRISE 20A 125V

Q2 CIRCUIT BREAKER / DISJONCTEUR 20A

X3 SOCKET / PRISE 20A 125V

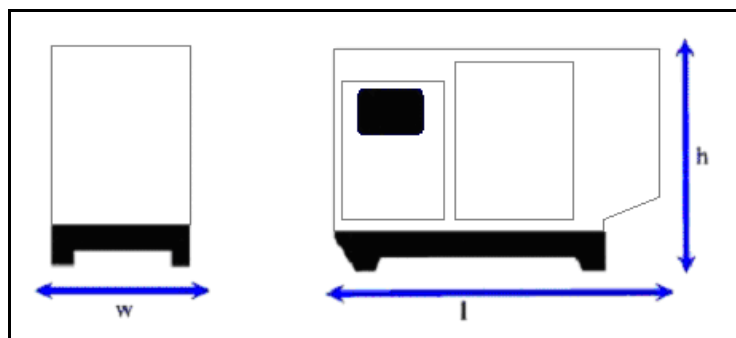
Q3 CIRCUIT BREAKER / DISJONCTEUR 20A

2.2. Technical specifications

| | |
|------------------------------------|----------------------|
| Range / Generating set type | RENTAL POWER / R340U |
|------------------------------------|----------------------|

| |
|-------------------------------|
| Weights and Dimensions |
|-------------------------------|

| |
|--------------------------------------|
| Dimensions with standard tank |
|--------------------------------------|



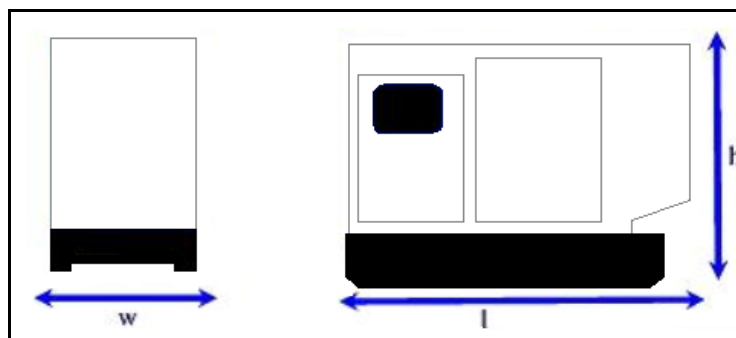
Dimensions l x w x h:
4475 mm x 1410 mm x 2690 mm

Weight:
3830 kg dry weight 4300 kg in operating configuration

Hood:
M228C

Noise level:
80 dB à 1 m (0.70)
70 dB à 7 m (0.70)

| |
|---|
| Dimensions with high autonomy tank |
|---|



Dimensions l x w x h:
4527 mm x 1410 mm x 2780 mm

Weight:
4520 kg dry weight 5888 kg in operating configuration

Hood:
M228C-DW

Noise level:
80 dB à 1 m (0.70)
70 dB à 7 m (0.70)

| |
|---------------|
| Output |
|---------------|

| Voltage | Hz | Phase | Load factor | Max current (A) Emergency | Emergency power ¹ kW / kVA | Prime power ² kW / kVA |
|-----------|----|-------|-------------|------------------------------|--|--------------------------------------|
| 480/277 V | 60 | 3 | 0.8 | 453 | 301.6 / 377 | 274.2 / 342.7 |
| 380/220 V | 60 | 3 | 0.8 | 573 | 301.6 / 377 | 274.2 / 342.7 |
| 220/127 V | 60 | 3 | 0.8 | 989 | 301.6 / 377 | 274.2 / 342.7 |
| 208/120 V | 60 | 3 | 0.8 | 1046 | 301.6 / 377 | 274.2 / 342.7 |

(1) ESP: Stand-by output available for emergency use under variable charge up to 200hrs per year as per ISO 8528-1, no overload available under these service conditions.

(2) PRP: Main output available continuously under variable load for an unlimited time period per year as per ISO 8528-1, an overload of 10% one hour every 12 hours is available, as per ISO3046-1.

| | |
|--|----------------|
| Engine data | |
| Manufacturer / model | VOLVO TAD941GE |
| Type | Turbo |
| Cylinder configuration | 6 L |
| Cubic capacity | 9.36 L |
| Rotation speed | 1800 Rpm |
| Max emergency/prime power at nominal speed | 344 / 313 kW |
| Adjustment type | Electrical |



| | |
|-------------------------|----------|
| Fuel consumption | |
| 110 % (emergency power) | 79.2 L/h |
| 100 % main power | 70.8 L/h |
| 75 % main power | 52.8 L/h |
| 50 % main power | 37.0 L/h |

| | |
|-------------------------|--------|
| Fuel | |
| Fuel type | Diesel |
| Standard fuel tank | 470 L |
| High autonomy fuel tank | 1368 L |

| | |
|------------------------------|----------|
| Lubrication | |
| Oil capacity with filter | 35 L |
| Min. Oil pressure | 0.7 bar |
| Nominal oil pressure | 6 bar |
| Oil consumption (100 % load) | 0,06 L/h |
| Oil sump capacity | 28 L |
| Type of lubricant | Genlub |

| | |
|-------------------------------|-----------------------|
| Cooling | |
| Engine capacity with radiator | 41 L |
| Max coolant temperature | 103 °C |
| Fan power | 17.8 kW |
| Ventilator air flow | 7.2 m ³ /s |
| Refrigerant type | Gencool |
| Thermostat | 82-92°C |

| | |
|--|--|
| Alternator data | |
| <ul style="list-style-type: none"> Compliant with NEMA MG21 standards, UTE NF C51.111, VDE 0530, BS 4999, IEC 34.1, CSA | <ul style="list-style-type: none"> The alternator is protected against short circuits Vacuum impregnation, epoxy winding, IP23 protection rating |
| Type | LEROY SOMER LSA462VL12 |
| Number of phases | 3 |
| Power factor (cos Phi) | 0.8 |
| Number of poles | 4 |
| Excitation type | AREP |
| Voltage regulator | R450 |
| Short-circuit current | 3 IN |
| Number of bearings | 1 |
| Coupling | Direct |

| | |
|--|---|
| Control unit(s) | |
| <p>TELYS</p>  | <p><u>Standard specifications:</u> Voltmeter, Ammeter, Frequency meter</p> <p><u>Alarms and faults:</u> Oil pressure, Water temperature, Start failure, Overspeed, Alternator min/max, Battery voltage min/max, Emergency stop</p> <p><u>Engine parameters:</u> Timer, Oil pressure, Water temperature, Fuel level, Engine speed, Battery voltage</p> |
| <p>KERYS</p>  | <p><u>Coupling:</u> pre-programmed coupling mode selector.</p> <p><u>Electrical measurements:</u> Voltmeter, Ammeter, Frequency meter</p> <p><u>Alarms and faults:</u> Oil pressure, Water temperature, Start failure, Overspeed, Alternator min/max, Battery voltage min/max, Emergency stop</p> <p><u>Engine parameters:</u> Timer, Oil pressure, Water temperature, Fuel level, Engine speed, Battery voltage</p> <p><u>Additional specifications :</u> Coupling Website, Troubleshooting, Assistance and maintenance, plotting and logging, load impact, 8 configurations available, Compliance with international standards...</p> |

2.3. Fuel and consumables

All specifications (product features) are given in the motor and alternator maintenance manuals attached to this manual. In addition, we recommend the consumables to be used in the "specifications" section.

2.3.1 Specifications

2.3.1.1. Oil grades

| Engine | | Oil | |
|------------|------|------------|--------------------|
| Make | Type | Make | Type |
| John Deere | All | John Deere | John Deere PLUS-50 |
| | | GenPARTS | GENLUB TDX 15W40 |
| MITSUBISHI | All | GenPARTS | GENLUB TDX 15W40 |
| Volvo | All | GenPARTS | GENLUB TDX 15W40 |

GENLUB TDX 15W-40

Top-of-the-range lubricant recommended for diesel engines: for generating sets used under severe conditions.

USES:

- ✓ Particularly suited to more modern engines with or without turbochargers, *intercoolers*, or sophisticated injection systems (e.g. **HEUI**, injector-pumps).
- ✓ **All types of use**: can cope with the most demanding applications.
- ✓ **Depolluted engines**: complies with EURO 2 and EURO 3 technology and can be used with all types of diesel fuel, especially ecological diesel with low sulphur content.

PERFORMANCE:

ACEA E3

API CH-4

- ✓ Meets level E3 of the specifications defined by European manufacturers in the ACEA standards 98 edition.

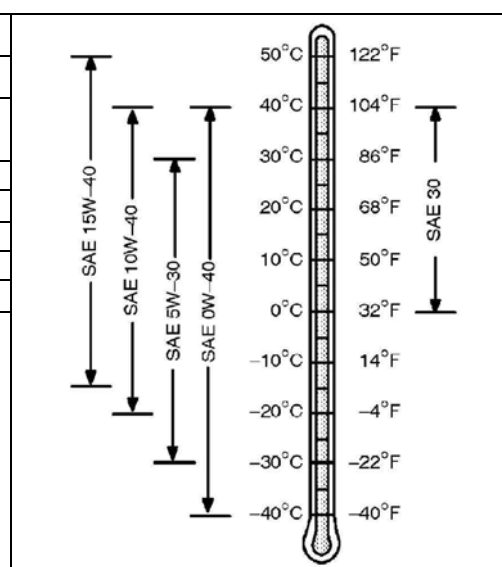
ADVANTAGES:

- ✓ **Less frequent oil services**: this product has been put to the test during thousands of hours of use on worksites under varying conditions, demonstrating its high quality.
- ✓ **Conformity with new environmental legislation**: adherence to new anti-pollution standards required for new EURO 2 and EURO 3 engines.

SPECIFICATIONS:

| SAE Grade | 15W-40 | |
|-------------------------------|--------|--------------------------|
| Density at 15°C | 0.883 | |
| Cinematic viscosity at 40 °C | 105 | mm ² /s (cSt) |
| Cinematic viscosity at 100 °C | 14.1 | mm ² /s (cSt) |
| Viscosity index | 140 | |
| Dynamic viscosity at -15 °C | 3000 | mPa.s(cP) |
| Pour point | - 30 | °C |
| Flash point | 220 | °C |
| Sulphated ash content | 1.4 | % weight |

(Values given as examples only)



2.3.1.2. Specifications of coolants

| Engine | | Coolants | |
|------------|------|------------|------------------|
| Make | Type | Make | Type |
| John Deere | All | GenPARTS | GENCOOL PC -26°C |
| MITSUBISHI | All | Mitsubishi | LLC |
| | | GenPARTS | GENCOOL PC -26°C |
| Volvo | All | GenPARTS | GENCOOL PC -26°C |

GenCOOL PC -26

High-protection coolant, approved by manufacturers.

GenCOOL PC -26 is a ready-to-use, highly protective coolant which is produced from an antifreeze recommended by the majority of European manufacturers.

- It is made from antifreeze and G 48 inhibitors.
- It protects up to -26°C.
- It is free from nitrates, amines and phosphates.
- It is a clear, fluorescent orange liquid.

REFERENCES/APPROVALS (for the antifreeze):

| HEAVY GOODS VEHICLE | LIGHTER VEHICLES |
|---|--|
| Approved by MTU, MERCEDES BENZ, MAN, KHD, GENERAL MOTORS | Approved by BMW, VOLKSWAGEN, MERCEDES, PORSCHE |
| Conforms with VOLVO, IVECO, VAN HOOL and STAYR TRUCK specifications | Conforms with VOLVO, OPEL, SEAT and SKODA specifications |

Conforms with the NF R 15.601 standard

REINFORCED ANTI-CORROSION FEATURES:

- Protects **against high-temperature corrosion** by oxidation of ethylene (cylinder head protection).
- Protects **against high-temperature cavitation** (top of cylinder and coolant pump protection).
- Non-corrosive for seals and hoses.
- Improves the **efficiency and longevity of the cooling system**.
- **GenCOOL PC -26** is especially recommended for engines fitted with aluminium or light alloy radiators.

HIGH TEMPERATURE SUITABILITY:

- Provides good conditions for thermal exchange.
- Perfect stability at high temperatures.
- **GenCOOL PC -26** is specially adapted for engines with high power densities.

LONG LASTING PROTECTION:

- High alkaline reserve/stability and longevity of corrosion inhibitors.
- Maintains its technical properties during prolonged use at high temperatures (neutralisation of acids).
- Ensures maximum heat transfer without the build up of deposits in the cooling system.
- **GenCOOL PC -26** ensures optimum protection against overheating and corrosion in extreme conditions of vehicle use.

PACKAGING/STORAGE:

- **GenCOOL PC -26** is supplied in 210 l metallic barrels with smooth interior linings.
- It can be stored for 2 years in its original container and packaging.
- Avoid zinc coated containers.

RECOMMENDATIONS FOR USE:

- Compatible with the original fluid.
- It is recommended that the cooling system is completely drained when replacing the fluid.

| SPECIFICATIONS | UNITS | SPECIFIED VALUES | TRIAL METHODS |
|---|---------------------------|------------------|---------------|
| Density at 20°C | kg/m ³ | 1,059 +/- 3 | R 15-602-1 |
| pH | pH | 7.5 to 8.5 | NF T 78-103 |
| Alkalinity reserve | ml | >=10 | NF T 78-101 |
| Boiling point | °C | 105 +/- 2 | R 15-602-4 |
| Freezing point: | °C | -26 +/- 2 | NF T 78-102 |
| Glassware corrosion : (test with antifreeze) | mg/test piece | | R 15-602-7 |
| - Copper | | +/- 2.6 | |
| - Weld | | +/- 0.5 | |
| - Brass | | +/- 2.3 | |
| - Steel | | +/- 1.6 | |
| - Cast iron | | +/- 0.8 | |
| - Cast aluminium | | +/- 1.0 | |
| Corrosion on warm plate (test with antifreeze) | mg/(cm ² week) | +/- 0.17 | R 15-602-8 |

3. Installation**3.1. Unloading****3.1.1 Safety during unloading**

To unload electrical generating sets from their transport supports under optimum safety and efficiency conditions, you need to ensure that the following points are observed:

- Lifting machinery or equipment appropriate to the work required.
- Slings positioned in the eyes provided for this operation or lifting arms resting fully underneath the chassis cross members.
- Ground able to take the load of the set and the lifting machinery without stress (otherwise lay down beams of sufficient strength and stability).
- Set put down as close as possible to its point of use or transportation, in a clear area with free access.

Example of equipment to be used:

- ✓ crane, slings, cross bar, safety catch, shackles.
- ✓ Fork lift truck.

3.1.2 Instructions for unloading**3.1.2.1. Slings**

- ➊ Attach the lifting vehicle slings to the rings on the generating set designed for this procedure. Hang the slings carefully.
- ➋ Check that the slings are correctly attached and the equipment is solid.
- ➌ Lift the generating set carefully.
- ➍ Direct and stabilise the set towards the chosen position.
- ➎ Carefully set down the equipment while continuing to position it.
- ➏ Release the slings, then detach and remove the lifting rings.

3.1.2.2. Fork lift truck

- ❶ Position the forklift arms under the base frame (except with generating sets fitted with "forklift pockets", in which case position the forklift arms in these pockets), making sure that only its cross-members are resting on the arms.
- ❷ Lift the equipment, handling it gently.
- ❸ Set down the generating set in its unloading position.

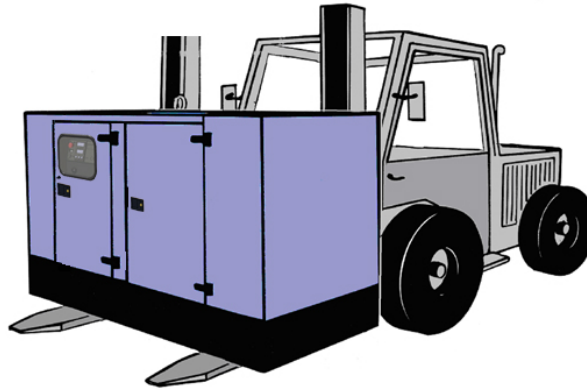


Figure 3.1: Transporting a generating set using a forklift truck

3.2. Fluid retention

Any outflow of the fluids contained in the generating sets (fuel, oil and coolant, or rainwater or condensation) will be collected in a retention container if the generating set is fitted with this option.

The containers have a capacity which allows 110% of the fluids contained in the generating set fitted with this option to be collected. Three different fittings are available.

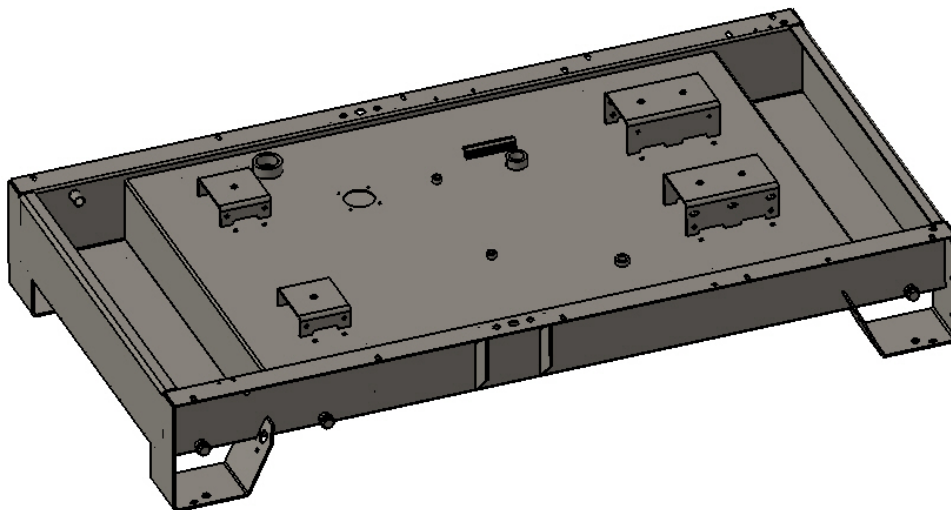


Figure 3.2: Fluid retention container integrated into the tank chassis.

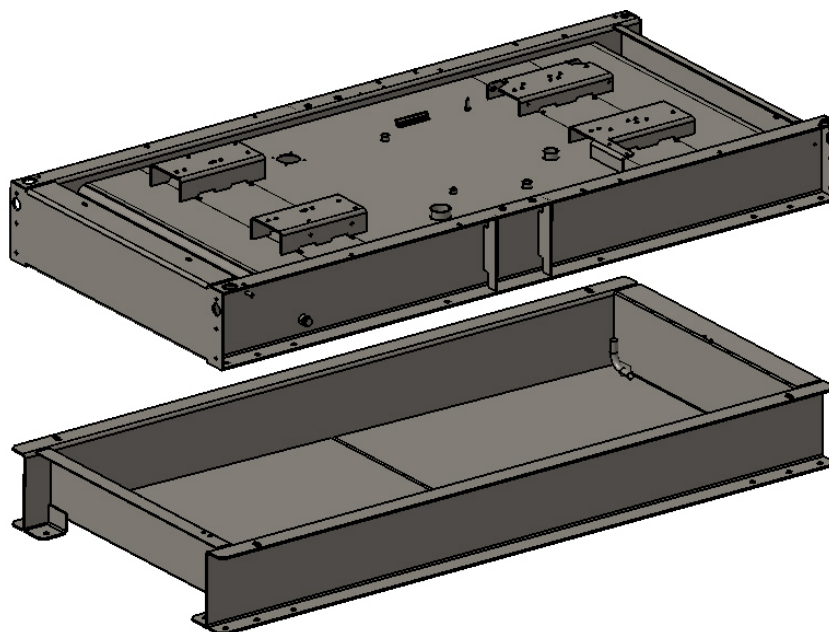


Figure 3.3: Offset fluid retention container underneath the generating set chassis.

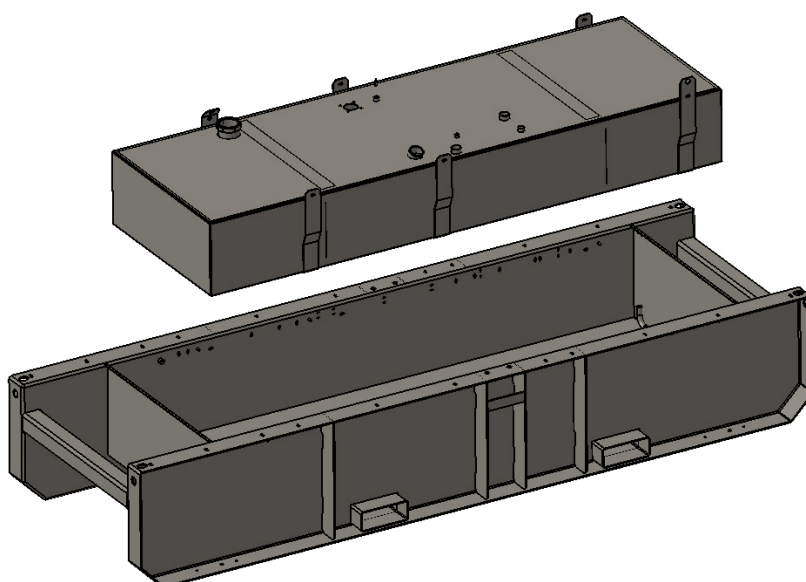


Figure 3.4: Offset fluid retention container integrated into the chassis and tank.

Generating sets fitted with the offset tank option (DW) above also have a high level indicator in the retention container.

In all cases, the retention containers must be regularly checked to ensure they contain no fluid (fuel, oil and coolant, or rainwater or condensation). If necessary, drain the containers either via the drain port or by using the drain pump (for containers fitted with this pump).

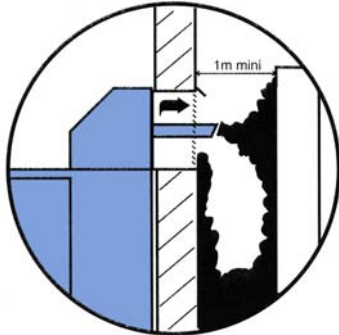
- ✓ **Note:** Never allow these fluids to drain onto the ground; ensure they are collected in a designated container.

3.3. Choice of location

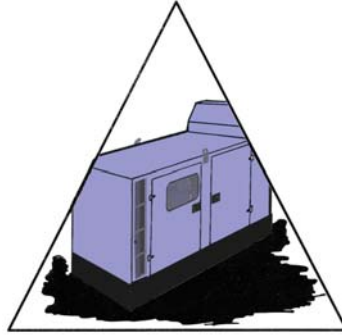
It should be determined on the basis of use. There are no specific rules governing the choice of location, other than proximity to the electric distribution panel and disturbances caused by the noise. However, fuel supply, burnt gas evacuation, and the direction of these gases and the noises emitted should be taken into account.

The choice of its position will be based on carefully considered compromise!

Examples of problems that may be encountered:



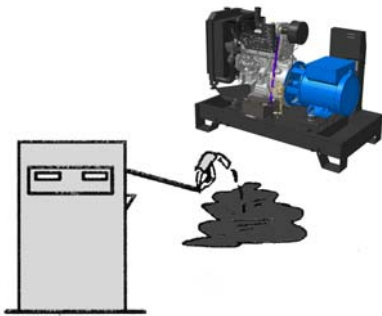
Incorrect exhaust and ventilation



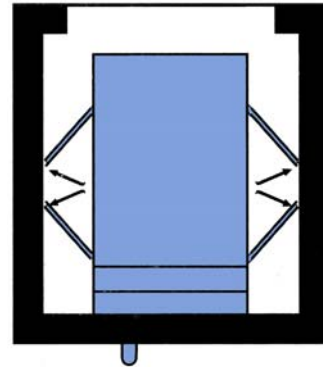
Ground too uneven or soft.
Set incorrectly positioned



Reduced access



Fuel filling impossible



Opening cover doors impossible

Figure 3.5: Examples of problems that may be encountered

3.4. Electricity

a) Connections - general information

As with low voltage electrical installations, use and maintenance is governed by standard NFC 15.100 (France) or by the standards in the relevant country, based on international standard IEC 60364-6-61.

They must also adhere to the regulations in the NFC 15.401 application guide (France) or to the regulations and standards in the relevant country.

b) Power cables

These can be unipolar or multipolar according to the power of the generating set.

Power cables should preferably be installed in ducts or on a cable tray for this purpose.

The cable cross-section and number of cables should be determined according to the cable type and the current standards to be observed in the country of installation. The choice of conductors must comply with international standard IEC 30364-5-52.

Three phase - Calculation hypothesis

Fitting method = wiring in cable runs or non perforated trays.

Permissible voltage drop = 5%

Multiconductors or single conductor joined when precision 4X...(1)

Cable type PVC 70°C (e.g. H07RNF).

Ambient temperature = 30°C.

| Circuit breaker calibre (A) | Cable sizes | | |
|-----------------------------------|------------------------------|--------------------------|--------------------------|
| | 0 - 50m | 51 - 100m | 101 - 150m |
| | mm²/AWG | mm²/AWG | mm²/AWG |
| 10 | 1.5 / 14 | 2.5 / 12 | 4 / 10 |
| 16 | 2.5 / 12 | 4 / 10 | 6 / 9 |
| 20 | 2.5 / 12 | 4 / 10 | 6 / 9 |
| 25 | 4 / 10 | 6 / 9 | 10 / 7 |
| 32 | 6 / 9 | 6 / 9 | 10 / 7 |
| 40 | 10 / 7 | 10 / 7 | 16 / 5 |
| 50 | 10 / 7 | 10 / 7 | 16 / 5 |
| 63 | 16 / 5 | 16 / 5 | 25 / 3 |
| 80 | 25 / 3 | 25 / 3 | 35 / 2 |
| 100 | 35 / 2 | 35 / 2 | 4X(1X50) / 0 |
| 125 | (1) 4X(1X50) / 0 | 4X(1X50) / 0 | 4X(1X70) / 2/0 |
| 160 | (1) 4X(1X70) / 2/0 | 4X(1X70) / 2/0 | 4X(1X95) / 4/0 |
| 250 | (1) 4X(1X95) / 4/0 | 4X(1X150) / 2350MCM | 4X(1X150) / 2350MCM |
| 400 | (1) 4X(1X185) / 0400MCM | 4X(1X185) / 0400MCM | 4X(1X185) / 0400MCM |
| 630 | (1) 4X(2X1X150) / 2x 2350MCM | 4X(2X1X150) / 2x 2350MCM | 4X(2X1X150) / 2x 2350MCM |

Single phase - Calculation hypothesis

Fitting method = wiring in cable runs or non perforated trays.

Permissible voltage drop = 5%

Multiconductors.

Cable type PVC 70°C (e.g. H07RNF).

Ambient temperature = 30°C.

| Circuit breaker rating (A) | Cable sizes | | |
|-------------------------------|-------------|-----------|---------------|
| | 0 - 50m | 51 - 100m | 101 - 150m |
| | mm²/AWG | mm²/AWG | mm²/AWG |
| 10 | 4 / 10 | 10 / 7 | 10 / 7 |
| 16 | 6 / 9 | 10 / 7 | 16 / 5 |
| 20 | 10 / 7 | 16 / 5 | 25 / 3 |
| 25 | 10 / 7 | 16 / 5 | 25 / 3 |
| 32 | 10 / 7 | 25 / 3 | 35 / 2 |
| 40 | 16 / 5 | 35 / 2 | 50 / 0 |
| 50 | 16 / 5 | 35 / 2 | 50 / 0 |
| 63 | 25 / 3 | 50 / 0 | 70 / 2/0 |
| 80 | 35 / 2 | 50 / 0 | 95 / 4/0 |
| 100 | 35 / 2 | 70 / 2/0 | 95 / 4/0 |
| 125 | 50 / 0 | 95 / 4/0 | 120 / 2250MCM |

c) Battery cables

Install the battery or batteries in the immediate vicinity of the electric starter motor. The cables will be connected directly from the battery terminals to the starter motor terminals.


The primary instruction to follow is to ensure that the polarities between the battery and starter motor match. Never reverse the positive and negative battery terminals when connecting them. This could cause severe damage to the electrical equipment.

The minimum cross-section of the cables will be 70 mm². It varies according to the power of the starter motor but also the distance between the batteries and the set (voltage drops on the line).

d) Safety guidelines

References: NFC 15-100:2002 (France) - IEC: 60364-5-54

In order to protect personnel against electric shocks, this generating set is equipped with a differential residual current protector "factory" set to trigger instantly, with a sensitivity of 30 mA.

| | |
|---|---|
|  | <p>Any modification to this setting could endanger personnel. Any modification would render the user liable, and must only be performed by qualified and authorised personnel.</p> <p>When the generating set is disconnected from a facility after use, the master differential protector must be returned to its "factory" settings, and this must be checked by trained personnel.</p> |
| Important | |

For effective protection against electric shocks, the generating set needs to be earthed. To do this, use a copper wire, with a minimum cross-section of 25 mm² for a stripped cable and 16 mm² for an insulated cable, connected to the generating set earth socket and a galvanised steel earthing rod embedded vertically into the ground.

The earthing rod resistance value should comply with the values shown in the table below.

Note: use the highest differential setting from the installation as a guideline.

The resistance value is calculated in the following way:
$$R = \frac{UI}{I \Delta n}$$

Maximum resistance value of the earth socket R (Ω) according to the differential unit operational current (operation time should not be longer than 1 second).

| I Δn differential | Earth R (Ω) UI: 50 V | Earth R (Ω) UI: 25 V |
|----------------------|----------------------------|----------------------------|
| ≤ 30 mA | 500 | > 500 |
| 100 mA | 500 | 250 |
| 300 mA | 167 | 83 |
| 500 mA | 100 | 50 |
| 1A | 50 | 25 |
| 3A | 17 | 8 |
| 5A | 10 | 5 |
| 10A | 5 | 2.5 |

The UI value: 25 V is required for work site installations, and livestock buildings, etc.

For a default voltage of 25 V and a default current of 30 mA, this rod must be of a minimum length of: see table below:

| Nature of ground | Length of rod in metres | |
|---|-------------------------------|---|
| Thick arable land, moist compact ballast | 1 | |
| Lean arable land, Gravel, coarse ballast | 1 | |
| Bare stony soils, dry sand, impermeable rock | 3.6 | To obtain an equivalent length, you can use several earthing rods connected in parallel and set apart by at least their length. Example: 4 interconnected 1 metre rods separated by 1 metre. |

Note: For the United States (National Electrical Code reference NFPA-70).

The generating set must be earthed. To do this, use a copper wire with a minimum cross-section of 13.3 mm² (or AWG 6, at most) connected to the generating set earth socket and a galvanised steel earthing rod fully embedded into the ground vertically.

This earthing rod embedded fully in the ground must have a minimum length of 2.5 m.

3.5. Special arrangements

Generating sets are not fitted with protection against power surges caused by drops in atmospheric pressure or manoeuvring.


The company does not accept any responsibility regarding damage caused by these occurrences.

However, lightning conductors can be installed, on the understanding that this does not give total protection.

4. Trailer

4.1. Trailer linkage

Before attaching the trailer, check the trailer hook on the tow vehicle; it should fit the trailer ring perfectly.

| | |
|---|--|
|  | <p>Trying to tow a trailer with a non-matching device (bar, wires, cords, etc.) could lead to serious accidents. Also check: - no incipient fractures or excessive wear on the hitching system. - locking system is operating properly.</p> |
| Warning | |

To hitch the trailer, proceed as follows:

- ❶ Lock the wheels to stop the trailer from moving
- ❷ Lift up the rear trailer supports and lock them
- ❸ Release the parking brake
- ❹ Release the locking levers for the draw bar arms and adjust the ring to the same height as the vehicle hook
- ❺ Hitch the trailer, remove the locks on each side of the wheels then lift up the front wheel fully using its handle
- ❻ Connect the electrical circuit of the trailer to that of the tow vehicle
- ❼ Hook the handbrake safety wire onto the hook on the tow vehicle.

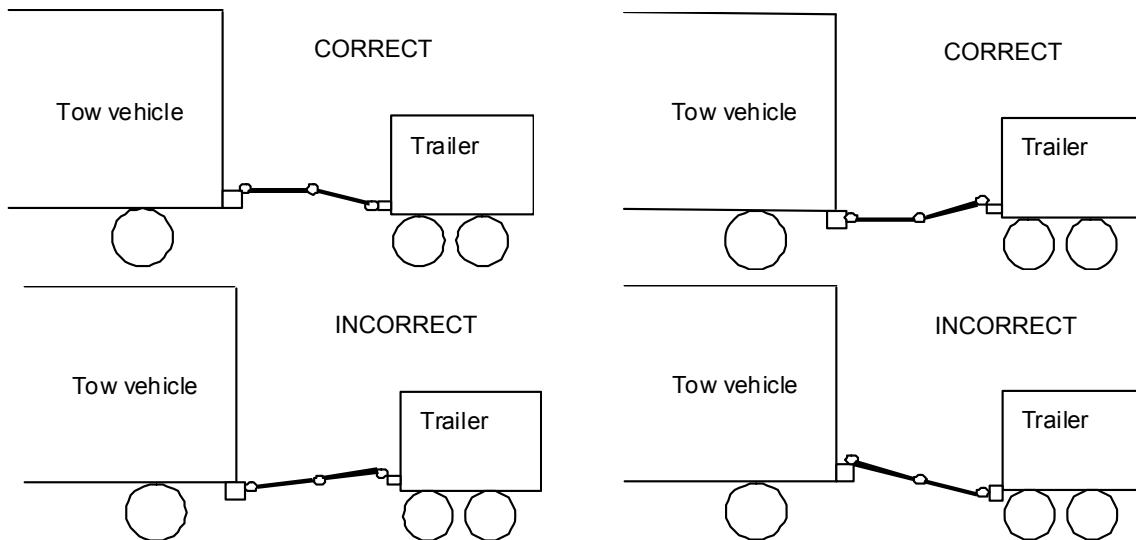


Figure 4.1 : Coupling a trailer

4.2. Check before towing

Before towing, check the following:

- ✓ Tightness of the generating set enclosure bolts.
- ✓ Wheel tightness.
- ✓ Hitching hook locked.
- ✓ Tyre pressure.
- ✓ Signalling lights working, for "on-road" trailers.
- ✓ Enclosure doors closed.
- ✓ Parking brake released, for "on-road" trailers.
- ✓ Guide wheels (jockey wheels) and stands lifted (if fitted).
- ✓ Towbar arm locking levers tightened and pinned (if fitted with an adjustable towbar).
- ✓ Brake test, for "on-road" trailers.
- ✓ Safety cable fitted, for "on-road" trailers.

4.3. Operation

"On-site" trailer


These trailers are not fitted with a main brake, and so cannot be braked in motion; the tyres allow for a maximum speed of 27 km/h. So it is absolutely prohibited to exceed this speed.

Nor are these trailers fitted with signalling lights. On-road use is prohibited.

"On-road" trailer

The driving speed must be suited to the condition of the road and the handling of the trailer.

Driving at high speed causes heating of the tyres; so it is important to stop from time to time, and check them. Excessive heating may cause a puncture, and therefore a serious accident. For reversing manoeuvres, remember to lock the inertia brake.

| | |
|---|--|
|  | <p>Particular attention must be paid to the tightness of the wheels on new vehicles. In the first few miles' driving, heating of the brake hubs and drums will actually reduce the wheel tightness. It is therefore essential to check the tightness every 6 miles (10 kilometres) until no further loosening is noted. Nonetheless the tightness must be checked whenever you are about to tow the trailer.</p> |
| <p>Warning</p> | |

Lights/signalling (only for "on-road" trailers)

Warning lights are obligatory for on-road driving. Signalling must comply with regulations in force in the country of use.

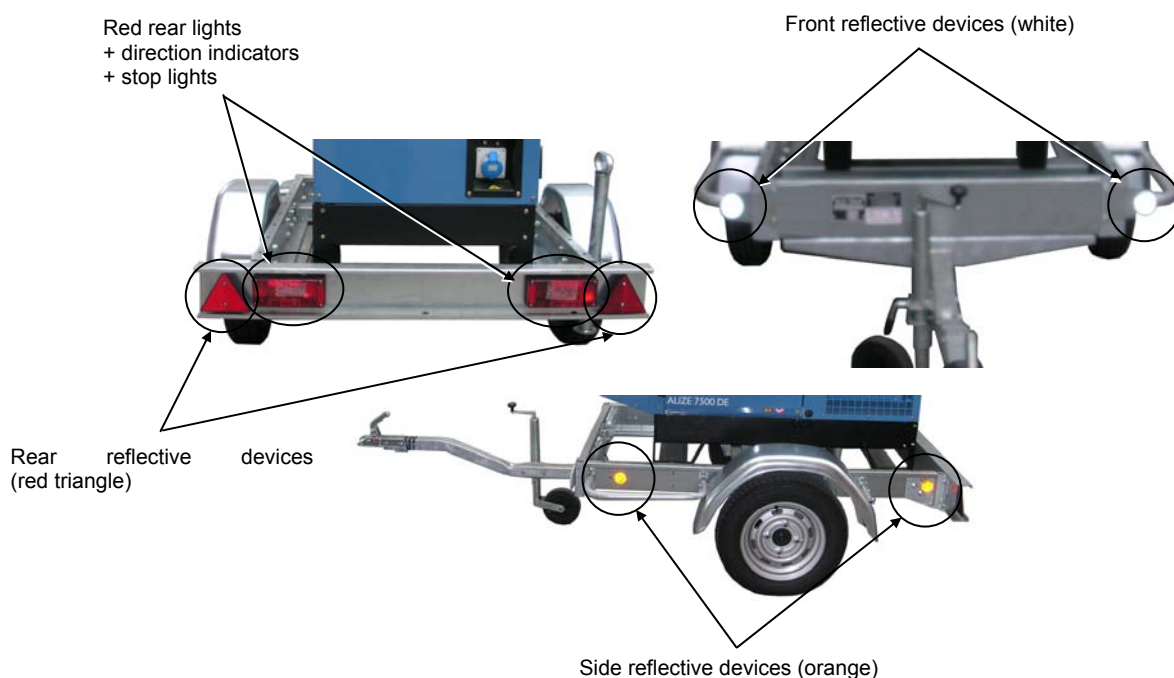


Figure 4.2: Example of French signalling

4.4. Unhitching the trailer

This operation should be carried out on horizontal, flat, stable ground.


- ❶ Lock the wheels
- ❷ Lower the front wheel
- ❸ Disconnect the road signals wire
- ❹ Refit the hitch using the wheel to release the hook ring from the tow vehicle,
- ❺ Release the tow vehicle
- ❻ Engage the handbrake.

4.5. Implementation for installation

Operations to be carried out:

- ❶ Ensure that the ground is strong enough for the assembly not to sink into it.
- ❷ Unhitch the trailer.
- ❸ Immobilise the trailer by placing chocks under the wheels.
- ❹ Fully engage the parking brake (if fitted).
- ❺ Using the front wheel, position the generating set as close to horizontal as possible.
- ❻ Lower the stands (if fitted), and lock them.

4.6. Break transmission adjustment

| | |
|---|--|
|  | <ul style="list-style-type: none"> - The handbrake is used only as a parking brake. - Setting is carried out starting with the brakes moving to the brake control. |
| Important | |

- ❶ After fitting the wheels on the axle, turn the wheels in the FORWARD direction (on all RA 2 type brakes, check that the adjustment screw 8 reaches the "FORWARD" stop on the brake backing plate).
- ❷ Adjust the brake setting using screw 8, with the cables not connected to the cross bar(s). The shoes should rub the drum slightly.
- ❸ Connect the brake cables to the cross bars(s) and tighten the nuts and lock nuts, leaving the end of the threaded end protruding by around 10 mm (Fig. 4.4).

IMPORTANT: Wherever possible, cables must cross over to achieve the highest possible gain curve (Fig. 4.5).

- ❹ Check that the parking lever 1 is in the 'REST' position and that the compensating spring 4 is completely free on its rod (unscrew the nuts 5 fully).
- ❺ Check that the hook slide 2 is not compressed and the yoke 3 is in the pulled out position.
- ❻ Fit the transmission and adjust the assembly using the tensioner 6 until a gap (J1) of 1 mm max is obtained between the linkage 9 and slide 2.
- ❼ Adjust the compensating spring 4 at one end pressing it against the anchorage plate, and at the other end leaving a 2 mm gap (J2) max between the spring and nuts 5.
- ❽ Tighten all the lock nuts.

Checking the setting (trailer on axle stands):

- ❶ Pull the parking lever 2 notches - the wheels cannot turn in a FORWARD direction.
The wheels can turn in REVERSE (adjustment screw 8 switches to the REAR position).
- ❷ Pull the parking lever fully.
The wheels will not turn either in FORWARD or REVERSE and the cross bar(s) must remain parallel with the axle body.
 - Check the transmission setting after 180 miles (300 km) (running in period) and if necessary adjust the gap (J1) using the tensioner.

Parking

- The lever must be fully pulled up, so that the compensating spring is fully compressed.
- Every 900 miles (1500 km), check the braking settings and distribution on all the wheels.

Important

- The brake controls are designed to draw trailers behind flexible suspension touring vehicles. If used behind an HGV, be sure to provide the fitted ball joint with a shock absorber to prevent premature wear.
- During any manoeuvres with the trailer coupled, do not turn more than 90° or force reverse.
- The specifications of our brake controls are indicated on a manufacturer's plate, and the items on this should be supplied to us when requesting replacement parts, in particular for the shock absorber, of a special type, approved by the Service des Mines to correspond to European standards (it is advisable to have a spare shock absorber to enable instant repairs).

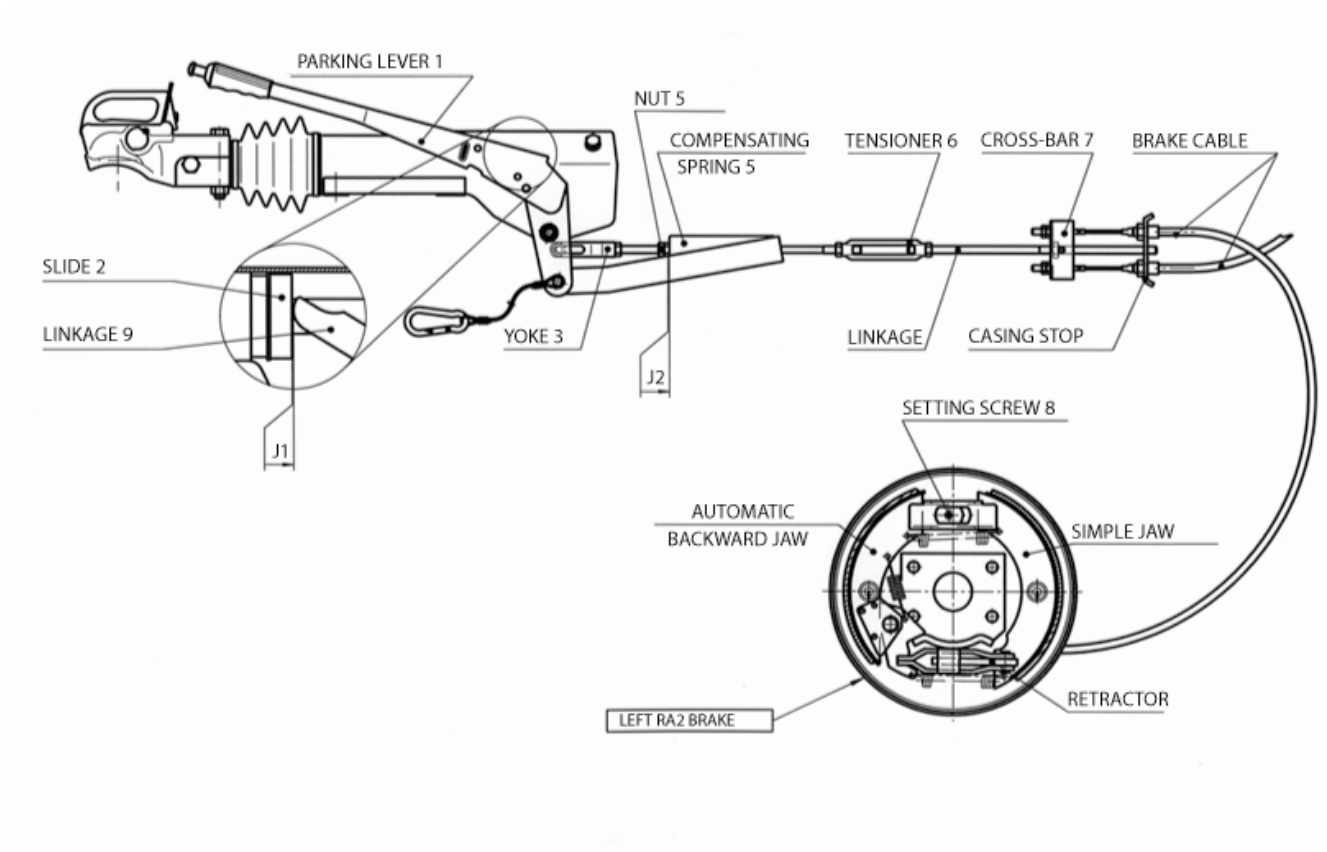


Figure 4.3: Braking transmission

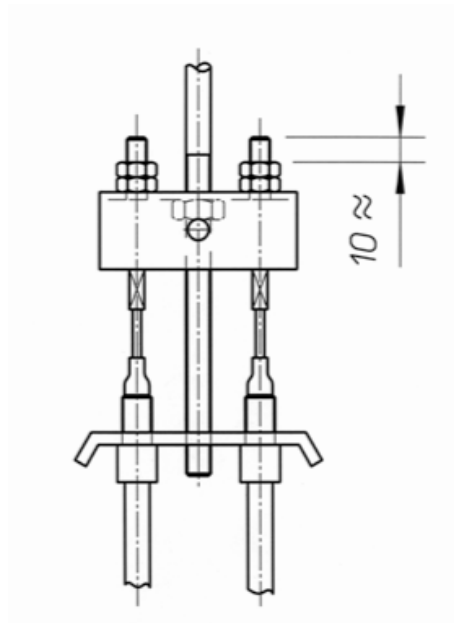


Figure 4.4: Cross bar fitting

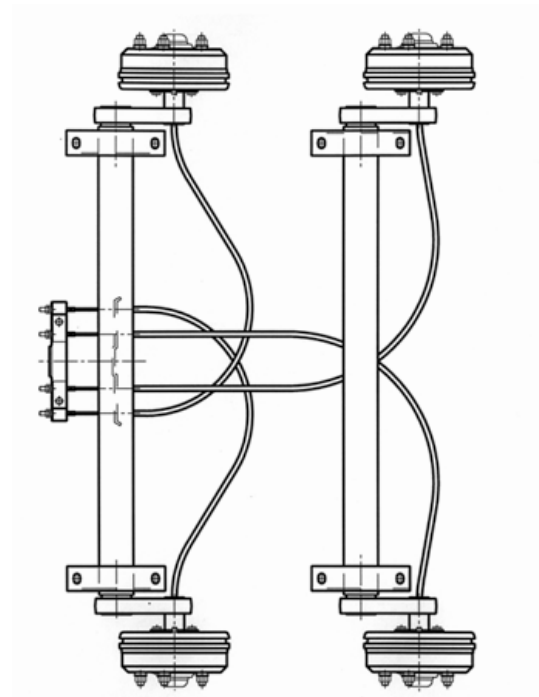


Figure 4.5: Tandem bearing fitting

4.7. Faults and repairs

| Fault observed | Origin | Solutions |
|---|---|--|
| Erratic braking of trailer | - Faulty shock absorber | Replace the shock absorber |
| Braking too weak | - Jaws worn | Replace the jaws |
| | - Jaws not run in | Fault will disappear only after running in |
| | - Incorrect linkage setting | Adjust the setting |
| | - Significant friction on the slide | Grease the sliding parts |
| | - Slide corrosion | Remove the corrosion and grease |
| Drum temperature abnormally high | - Coupling height does not match that of the towing vehicle | Adjust the height so that the two parts are in the same horizontal plane |
| | - Incorrect linkage setting | Adjust the settings |
| | - Incorrect brake setting | Adjust the settings |
| | - High levels of dust in the drums | Remove the dust |
| | - Jaws, springs, drums damaged | Replace the damaged parts |
| Jerky braking | - Brake cables or link rod damaged | Replace the damaged parts |
| | - Incorrect linkage setting | Adjust the settings |
| | - Interfering parts on the slide | Remove, clean and grease |
| | - Corroded slide | Remove the corrosion and grease |
| | - Damage to slide guide rings | Replace the rings (and possibly the slide) and grease |
| Trailer tending to swerve upon braking | - Faulty shock absorber | Replace the shock absorber |
| | - Cross-bar(s) not balanced | Adjust the cross-bar(s) |
| | - Different brake setting on the two sides | Adjust the brake settings |
| | - Cables damaged or incorrectly fitted | Replace the damaged parts Refit the cables |
| When starting the trailer holds back the towing vehicle | - Poor load distribution | Check the load distribution |
| | - Damage to slide or to guide rings | Replace the faulty parts and grease |
| | - Slide corrosion | Remove the corrosion and grease |
| | - Tie rod damaged | Replace the tie rod and adjust the settings |
| | - Linkage damaged or incorrectly set | Replace the damaged parts and adjust the settings |
| Play in the coupling head | - Brake on | Loosen the brake |
| | - Head worn (see wear indicator) | Replace the head |
| Parking braking too weak | - Ball joint worn | Replace the ball joint |
| | - Compensating spring incorrectly set | Adjust the setting |
| | - Braking system incorrectly set | Adjust the setting |
| | - Notched sector damaged | Replace the sector and adjust the setting |
| | - Lever ratchet worn | Replace the lever and adjust the setting |
| | - Cable ruptured | Replace the cable and adjust the setting |

4.8. Electrical connection diagram

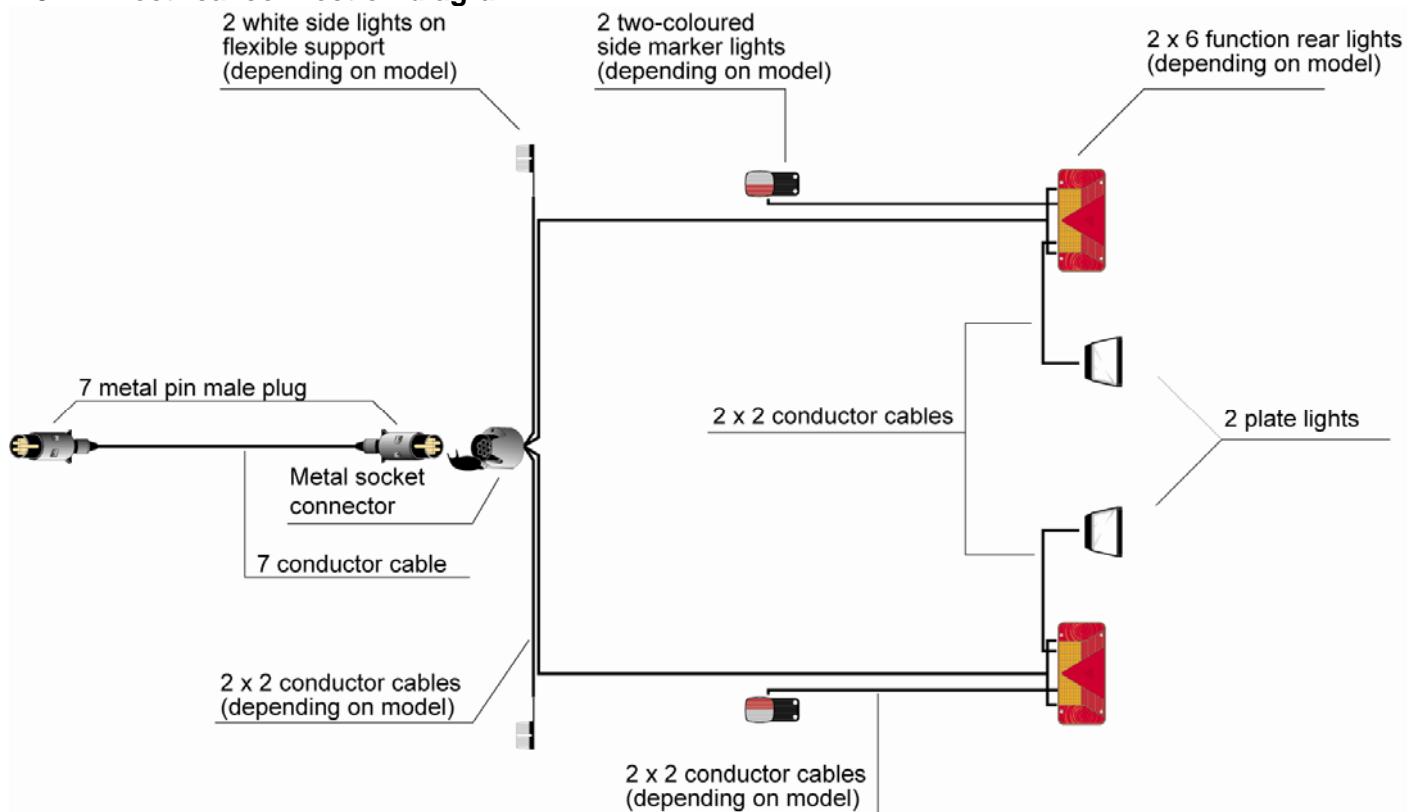


Figure 4.6 : Electrical connection diagram


4.9. Complete wheels technical information

| TYRES | | | | | COMPLETE WHEELS | |
|-------------|---------|---------------|--------------------|------------------------|--|----------------|
| Dimensions | Indices | Diameter (mm) | Cross section (mm) | Radius under load (mm) | Load (Kg) | Pressure (bar) |
| 135 R 13 | 70 T | 550 | 134 | 265 | 335 | 2.4 |
| 145 R 13 | 75 T | 566 | 145 | 272 | 387 | 2.4 |
| 155 R 13 | 79 T | 578 | 150 | 277 | 437 | 2.4 |
| 145/70 R 13 | 71 T | 534 | 150 | 259 | 345 | 2.5 |
| 155/70 R 13 | 75 T | 548 | 147 | 263 | 387 | 2.5 |
| 185/70 R 13 | 86 T | 594 | 185 | 285 | 530 | 2.5 |
| 165 R 14 C | 98 N | 622 | 172 | 284 | 650 | 3.8 |
| 155/70 R12 | 100 N | 525 | 155 | 244 | 650 ⁽¹⁾ 800 ⁽²⁾ | 6.25 |
| 185 R 14 C | 102 P | 650 | 188 | 316 | 675 ⁽¹⁾ 850 ⁽²⁾ | 4.5 |
| 195 R 14 C | 106 P | 666 | 198 | 32 | 950 | 4.5 |
| 195/50 x 10 | 98 N | 450 | 190 | - | 750 | 6.0 |

⁽¹⁾ Wheel with 4 holes

⁽²⁾ Wheel with 5 holes

5. Preparation before operating the set

| | |
|---|---|
|  | <p>The inspections referred to in this section enable the electrical generator set to operate. Specific skills are required to carry out these operations. They must only be entrusted to personnel with the necessary skills. Failure to follow these instructions in any way could result in malfunction or very serious accidents.</p> |
| Danger | |

5.1. Installation checks

- ✓ Check that the general recommendations given in the installation section (ventilation, exhaust, fluids, etc.) are observed.
- ✓ Carry out the level checks (oil, water, diesel fuel, battery).
- ✓ Check the generating set earth connection is earthed.
- ✓ Check that the electrical connections are in order.

5.2. Checks after starting the generating set

- ✓ Carry out the mechanical checks (oil pressure, water temperature, absence of noise etc.)
- ✓ Carry out the electrical checks (voltage and frequency)
- ✓ Carry out the safety checks (emergency stop, oil pressure, water temperature etc.)

6. Using the generator set

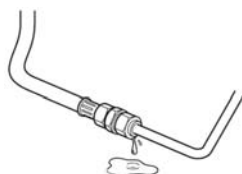
6.1. Pre-Start Inspection


• Engine and engine compartment, general check


Visually check the engine and engine compartment before starting the engine and after stopping the engine.


Check:

- there are no oil, fuel or coolant leaks,
- the screws are tightened,
- the condition of the belts (wear, tension).



| | |
|---|---|
|  | <p>Fuel, oil and grease deposits on the engine or in the engine compartment are always a fire hazard and must be removed as soon as they are noticed.</p> |
| Warning | |


| | |
|---|--|
|  | <p>If there are any oil, fuel or coolant leaks, locate the origin of the fault and repair it immediately before starting the engine.</p> |
| Important | |

| | |
|---|---|
|  | <p>Never use a high pressure cleaner for cleaning the engine and equipment.</p> |
| Important | |


• Oil level, check and top up


- Check the oil level every day before the first start-up.
- Check that it is between the MAX and MIN marks on the oil dipstick.
- If necessary, top up the oil through the filler opening, on the left-hand side of the engine.
Before checking the level again, wait a few minutes for the oil to drain into the sump.



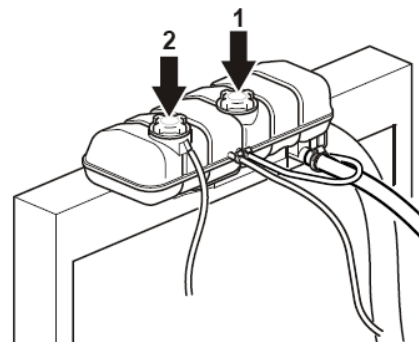
| | |
|---|--|
|  | <p>Never fill oil past the maximum level. Only use oil of the recommended grade.</p> |
| Important | |

• **Coolant level, check**


| | |
|---|---|
|  | Do not open the filler cap when the engine is hot, except in an emergency. Boiling liquid or vapour may be ejected. |
| Warning | |

| | |
|---|--|
|  | The system must be filled up with liquid which has identical proportions to that already contained in the cooling system. Only open the filler cap (1). |
| Important | |

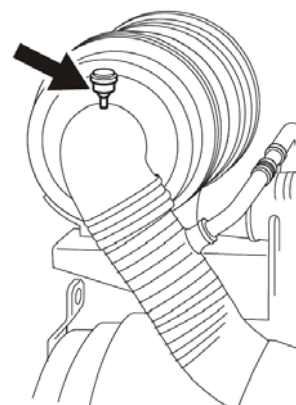
- The coolant level must be between the MIN and MAX marks. Top up the oil if necessary.



• **Checking the air filter clogging indicator**

| | |
|---|--|
|  | Special air filters must be used for extremely dusty conditions. |
| Important | |

- Replace the filter when the indicator remains in the red zone after the engine has been stopped.
- Reset the indicator after the filter has been replaced by pressing the button.



6.2. Generator set with TELYS control panel

6.2.1 Control panel presentation

6.2.1.1. View of the front panel

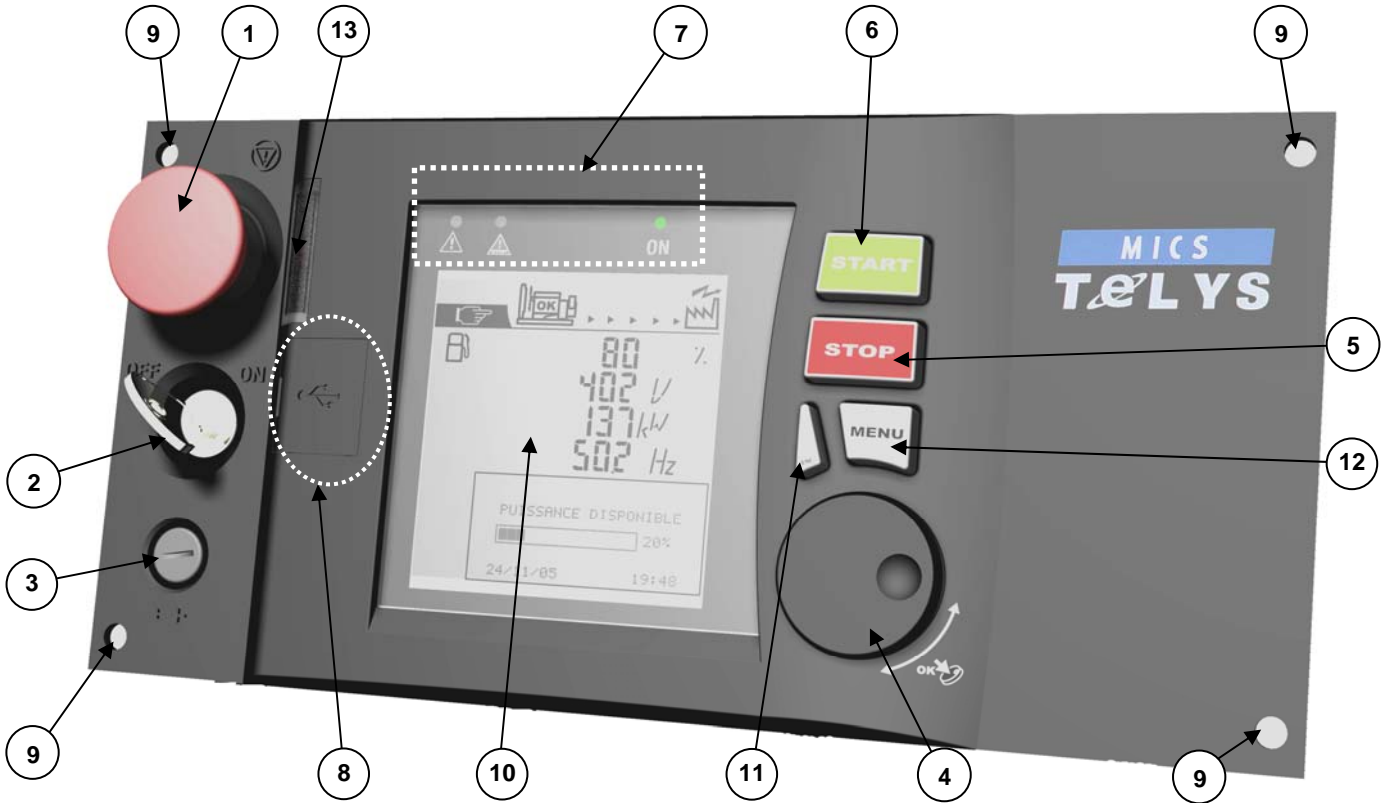


Figure 6.4 : View of the front panel

- 1 Emergency stop button (AU) for switching off the generating set in the event of a fault which could endanger personnel or damage equipment.
- 2 Key switch for switching the module on/off.
- 3 Electronic board protection fuse.
- 4 Scrolling and selection wheel for scrolling through the menus and screens and selecting items simply by pressing the wheel.
- 5 STOP button, press to switch off the generating set.
- 6 START button, press to switch on the generating set.
- 7 Power ON LEDs and alarm/fault warning LEDs.
- 8 Location of USB ports.
- 9 Mounting bolt.
- 10 LCD for displaying alarms and faults, operating statuses, electrical and mechanical quantities.
- 11 ESC button: for returning to the previous selection and for default RESET function.
- 12 MENU button for accessing the menus.
- 13 Lighting for the emergency stop button.



Figure 6.5 : Description of the LEDs

A lit LED indicates:

- 1 Alarm activated (flashing yellow).
- 2 Fault found (flashing red).
- 3 Module on (green, on continuously).

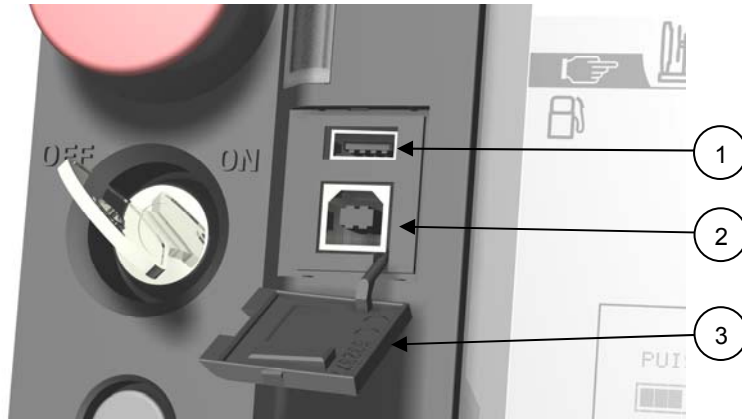


Figure 6.6: Close-up of USB ports

- 1 USB key connection (HOST): file transfer between USB key and TELYS and vice versa.
- 2 Connection for microcomputer (DEVICE):
 - file transfer between PC and TELYS and vice versa,
 - main module power supply.
- 3 Protective cover.

6.2.1.2. Description of the screen

The screen is backlit and requires no contrast adjustments. This screen is divided into 4 zones.

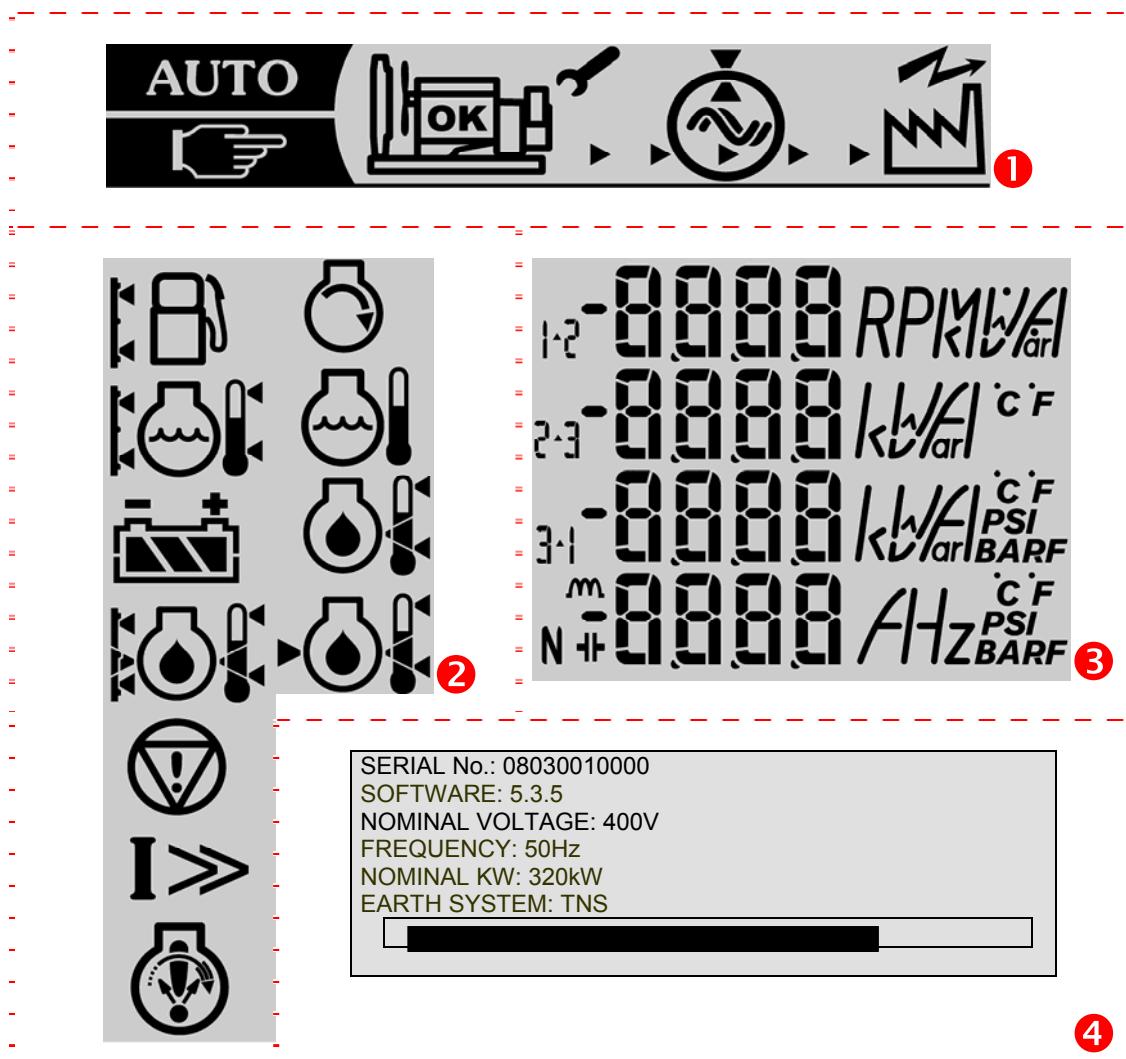










Figure 6.7: Description of the screen (example)

- ① Zone 1: in this zone, the status of the generating set is displayed
- ② Zone 2: in this zone, pictograms relating to dimensions measured are displayed, as well as Alarm and Fault pictograms
- ③ Zone 3: in this zone, the measured values corresponding to the measured dimensions are displayed with the corresponding units of measurement
- ④ Zone 4: in this zone, messages relating to the control of the generating set and the menus are displayed.

Note: the information displayed on measurements, alarms and faults as well as messages and menus relating to control of the generating set will depend on the equipment level of each generating set. Certain screens may therefore not be present.

6.2.1.3. Description of the pictograms in zone 1


















Pictograms in zone 1

| Pictograms | Display | Activation conditions |
|--|---|--|
|  "MANU" Mode | Fixed | TELYS in manual mode (MANU) |
| | Flashing | For 5 seconds when switching from AUTO mode to MANU mode |
|  "AUTO" Mode | Fixed | TELYS in automatic mode (AUTO) |
| | Flashing | For 5 seconds when switching from MANU mode to AUTO mode |
|  | Flashing | Generating set in start-up phase |
| | Fixed | Generating set started |
|  | Fixed | Generating set stabilised (voltage and frequency) |
|  | Flashing (appearance of constant movement from left to right) | The generating set is powering the installation |
|  | Fixed | The installation is supplied |
|  | Not used | |
|  | Not used | |

6.2.1.4. Description of the pictograms in zone 2

Alarm and fault pictograms in zone 2

All the pictograms in this zone are activated when TELYS is initialised.





| Data displayed | | | | | |
|---|--|---|---|--|---|
| Fuel level indicator | | | | | |
| Alarm / Fault low fuel level | |  | Alarm / Fault high fuel level | |  |
| Coolant level / temperature indicator | | | | | |
| Alarm Low level fault | |  | High level fault alarm | |  |
| Alarm High temperature fault | |  | No preheating fault alarm | |  |
| Battery | | | | | |
| Min battery voltage (flashing) | |  | Max battery voltage (flashing) | |  |
| | | | Battery charge indicator (flashing bars) | |  |
| Oil pressure / temperature indicator | | | | | |
| Oil pressure Alarm / Fault | |  | High or low oil level Alarm / Fault | |  |
| | | | High or low oil temperature Alarm / Fault | |  |
| Emergency stop | | | | | |
| Emergency stop fault | | | | |  |
| Overload or short circuit | | | | | |
| Tripping of circuit breaker following an overload or short circuit | | | | |  |
| Engine speed | | | | | |
| Underspeed fault | |  | Overspeed fault | |  |
| | | | Non-starting fault | |  |

6.2.1.5. Description of the pictograms in zone 3





Pictograms in zone 3

All the pictograms in these zones are activated when TELYS is initialised. The pictograms below are given as examples.


Generating set stopped

| Screen no. | Pictograms | Data displayed |
|------------|---|---|
| P1 |     | <p>80 %</p> <p>11 °C</p> <p>25.2 V</p> <p>12 °C</p> <p>Fuel Level Indicator</p> <p>Indication of Temperature of High Temperature coolant (HT) (units according to settings menu)</p> <p>Indication of Battery Voltage</p> <p>Indication of Oil Temperature (units according to settings menu)</p> |

Generating set start-up or generating set started or generating set switching off in progress

| Screen no. | Pictograms | Data displayed |
|------------|--|---|
| P2 |     | <p>600 RPM</p> <p>48 °C</p> <p>17 BAR</p> <p>43 °C</p> <p>Engine Speed Indication</p> <p>Indication of Temperature of High Temperature coolant (units according to settings menu)</p> <p>Indication of Oil Pressure (units according to settings)</p> <p>Indication of Oil Temperature (units according to settings menu)</p> |

Generating set started

| Screen no. | Pictograms | Data displayed |
|---|--|--|
| P3 Default screen in operation |  <div> 80 % 402 V 0 kW 502 Hz </div> | Fuel Level Indicator Alternator composite Voltage Indicator Total Active Power Indicator Alternator Frequency Indicator |
| P4 | <div> 1-2 2-3 3-1 </div> <div> 404 403 V 403 502 Hz </div> | U12 Alternator composite Voltage Indicator U23 Alternator composite Voltage Indicator U31 Alternator composite Voltage Indicator Alternator Frequency Indicator |
| P5 | <div> 1 2 3 </div> <div> 233 233 V 233 502 Hz </div> | V1 Alternator single Voltage Indicator V2 Alternator single Voltage Indicator V3 Alternator single Voltage Indicator Alternator Frequency Indicator |
| P6 | <div> 1-2 2 3-1 </div> <div> 230 115 V 115 502 Hz </div> | U12 Alternator composite Voltage Indicator V2 Alternator single Voltage Indicator V1 Alternator single Voltage Indicator Alternator Frequency Indicator |
| P7 | <div> 230 V 0 A 502 Hz </div> | V1 Alternator single Voltage Indicator Single phase Alternator current indicator Alternator Frequency Indicator |

| Screen no. | Pictograms | Data displayed |
|------------|------------|---|
| P8 | | Single phase Alternator current indicator Two phase Alternator current indicator Three phase Alternator current indicator Neutral Alternator current indicator |
| P9 | | Total Active Power Indicator Total Reactive Power Indicator Total Effective Power Indicator Total Power Factor Indicator (lagging or leading) |
| P10 | | Fuel Level Indicator Indication of Battery Voltage Indication of Battery Amps |

Screen order of appearance according to network type with the generating set on.

| Order of appearance | Type of network | | | |
|---------------------|-----------------|-----|------|------|
| | 3P+N | 3P | 2P+N | 1P+N |
| 1 | P3 | P3 | P3 | P3 |
| 2 | P4 | P4 | P6 | P7 |
| 3 | P5 | P8 | P8 | P9 |
| 4 | P8 | P9 | P9 | P2 |
| 5 | P9 | P2 | P2 | P10 |
| 6 | P2 | P10 | P10 | |
| 7 | P10 | | | |

Change screens by using the scrolling and selection wheel.

When the wheel is rotated clockwise, the screens scroll upwards and vice-versa.

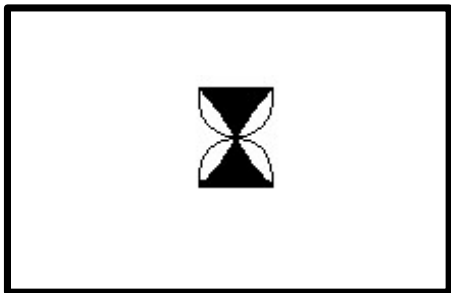
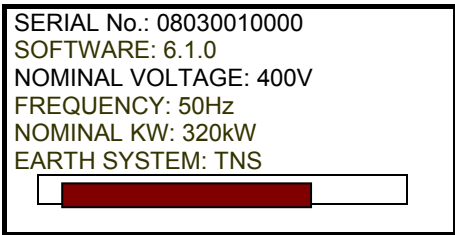
The screens scroll in a loop.

E.g.: On three-phase + neutral network, then screen 7, then screen 1 and vice-versa.

6.2.1.6. Display of messages in zone 4

The display (zone 4), among other things, displays messages relating to the operation of the generating set. The messages are as follows:

Initialisation of TELYS

| Screen no. | Screen | Data displayed |
|------------|--|--|
| G 1 |  | Initialisation of TELYS when the power is switched on and/or when loading a configuration |
| G 2 |  | Generating set serial no. Software version of TELYS Alternator Nominal Voltage Alternator Nominal Frequency Nominal Active Output Neutral Point Bar graph indicating the display delay of the screen |

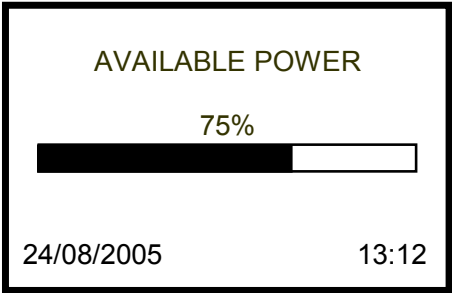

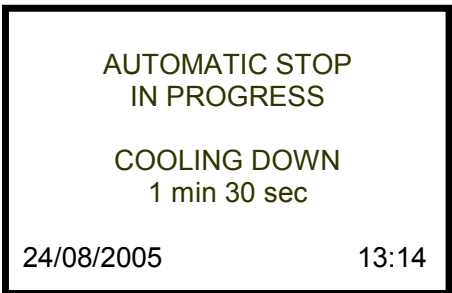
Generating set stopped

| Screen no. | Screen | Data displayed |
|------------|---|--|
| G 3 | <div> <p>OPERATION MANUAL</p> <p>Press START to start</p> <p>24/08/2005 13:12</p> </div> | <p>Operating mode - generating set in Manual Mode ready to start</p> <p>Date and time (depending on settings)</p> |
| G 4 | <div> <p>OPERATION AUTO</p> <p>WARNING START-UP POSSIBLE IMMEDIATELY</p> <p>24/08/2005 13:12</p> </div> | <p>Operating mode - generating set in Auto Mode ready to start</p> <p>Date and time (depending on settings)</p> |
| G 5 | <div> <p>WARNING</p> <p>AUTOMATIC Start 19 min 30 sec</p> <p>24/08/2005 13:12</p> </div> | <p>Operating mode - generating set in Auto Mode with programmed start</p> <p>Countdown to micro disconnection delay or EJP notice delay (for France only)</p> <p>Date and time (depending on settings)</p> |


Generating set start-up

| Screen no. | Screen | Data displayed |
|------------|--|---|
| G 6 | <div> <p>START-UP IN PROGRESS</p> <p>24/08/2005 13:12</p> </div> | <p>Operating phase - generating set in starting phase</p> <p>Date and time (depending on settings)</p> |
| G 7 | <div> <p>AIR PREHEATING</p> <p>10 seconds</p> <p>24/08/2005 13:12</p> </div> | <p>Operating phase - air preheating prior to starting generating set</p> <p>Countdown for air preheating delay</p> <p>Date and time (depending on settings)</p> |

Generating set started

| Screen no. | Screen | Data displayed |
|-----------------------|--|--|
| G 8 Default screen |  | <p>Operating phase – generating set in operation – stable voltage and frequency</p> <p>Available power</p> <p>Date and time (depending on settings)</p> |
| G 9 |  | <p>Operating mode - operation in Auto Mode</p> <p>Opening of power supply device (motorised circuit breaker or source changeover switch controlled by TELYS)</p> <p>Countdown for the mains return delay OR the load test delay</p> <p>Date and time (depending on settings)</p> |
| G 10 |  | <p>Operating mode - operation in Auto Mode</p> <p>Generation set cooling in progress</p> <p>Countdown for Engine Stop delay (cooling) OR Gradual Stop delay (Coolant temperature) OR Overload Gradual Stop delay OR OFF load test delay</p> <p>Date and time (depending on settings)</p> |

Generating setstop

| Screen no. | Screen | Data displayed |
|------------|---|---|
| G 11 |  | <p>Generating set stop in progress</p> <p>Date and time (depending on settings)</p> |


Operating mode changeover (switching from Manual Mode to Auto Mode following auto start demand)

| Screen no. | Screen | Data displayed |
|------------|--|---|
| G 12 | <div style="border: 2px solid black; padding: 10px; text-align: center;"> <p>Start Demand AUTO</p> <p>Do you wish to change to Auto Mode?</p> <p>WARNING Immediate start</p> <p>OK Esc</p> </div> | Operating mode - operation in Manual Mode AUTOMATIC start demand |

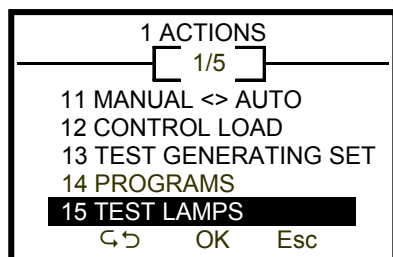
Generating set stop request due to fault or by pressing STOP in Auto Mode

| Screen no. | Screen | Data displayed |
|------------|---|--|
| G 13 | <div style="border: 2px solid black; padding: 10px; text-align: center;"> <p>Manual Mode activated</p> <p>Do you wish to change to AUTO mode?</p> <p>OK Esc</p> </div> | Operating mode - operation in Auto Mode (generating set in operation) Warning message for switching to Manual Mode after the STOP button has been pressed or a fault has appeared |

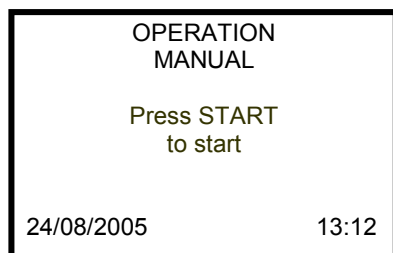
6.2.2 Starting

| | |
|---|--|
|  Danger | Check that the generating set circuit breaker has triggered. |
|---|--|

- ❶ Connect the generating set battery
- ❷ Turn the key switch to the ON position (without forcing it to the ON position), the ON lamp will light up (if the lamp does not light up, check and replace the fuse if necessary)
- ❸ Test the Alarm and Fault LEDs (menu 15 – TEST LAMPS)



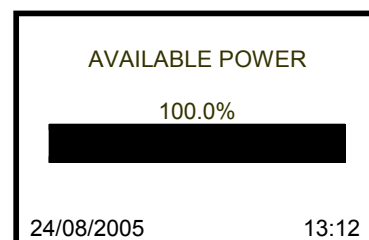
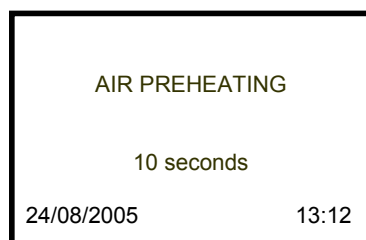
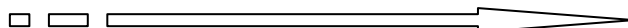
- ❹ Press "Esc" several times to return to the following home menu



- ❺ Check the battery voltage



- ❻ Press START:



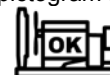
- If the engine is equipped with an air preheating system, there is a delay (adjustable) before the engine starts (preheating activation period).
- If the motor is not fitted with an air preheating system or once the preheating delay has elapsed, the engine starts up (start of a cycle comprising 3 attempts to start up the engine).

Warning: the number of successive and automatic starting attempts is limited to 3.

The following pictogram will flash



The following pictogram is displayed



The following information is displayed

| | | |
|--|---------------------|---------|
| | Speed of rotation | Options |
| | Coolant temperature | |
| | Oil pressure | |
| | Oil Temperature | |

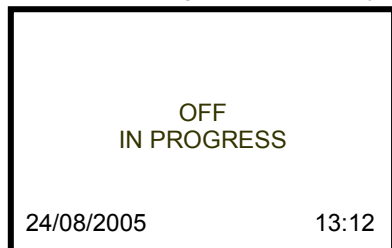
6.2.3 Switching off

- ① Open the circuit breaker manually OR by selecting menu 12 "CONTROL LOAD"

The following display will disappear (supply stopped)



- ② Press the STOP button
- ③ The following screen is displayed and the generating set will stop



- ④ Switch TELYS off by turning the key to "OFF" (without forcing it to the "OFF" position).

6.2.4 Alarms and faults

6.2.4.1. Viewing alarms and faults

Alarms and faults are displayed as follows:

- ① Alarms

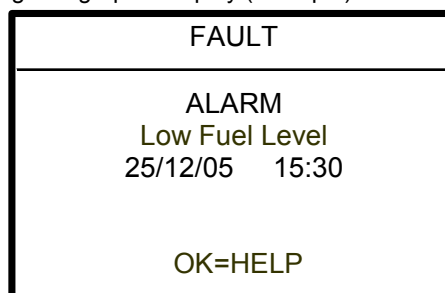
All alarms will cause:

- the yellow LED to flash "General alarm".



In conjunction with this LED:

- a flashing pictogram appears on the LCD screen representing the circuit affected by the alarm and the associated indicator, if present (example)
- message on graphic display (example)



- ② Faults

All faults will cause:

- **the generating set to stop: immediate or gradual stop (coolant temperature and overload or short circuit)**

- the red LED to flash "General fault".



In conjunction with this LED:

- a flashing pictogram appears on the LCD screen representing the circuit affected by the fault and the associated indicator, if present (example)
- message on graphic display (example)



| FAULT |
|--|
| FAULT Oil Pressure 25/12/05 15:30 OK=HELP |

Faults have priority over alarms. Faults are displayed in the descending order of their appearance (from the most recent to the oldest).

6.2.4.2. Activation of an alarm or fault

The appearance of an alarm or a fault causes the corresponding screen to be displayed (examples below)

| FAULT |
|---|
| ALARM Low coolant Level 06/10/06 10:30 OK=HELP |

| FAULT |
|---|
| FAULT Emergency Stop 06/10/06 15:30 Esc=RESET OK=HELP |

Press OK (on the scrolling and selection wheel) to access the help message if it is available (example below)

| HELP |
|---|
| Check the level fuel Esc=EXIT |

If the alarm is no longer active, it is reset automatically (cause disappears).

Press Esc to reset a fault:

- reset acknowledged if the cause of the fault has been removed
- reset not performed if the cause of the fault is still present.

6.2.4.3. Activation of an alarm and a fault

The appearance of an alarm **and** a fault causes:

- The yellow and red LEDs to flash
- the related screen to be displayed (example below)

| | |
|---|---------|
| FAULTS 1/2 | |
| FAULT Emergency Stop 25/12/05 15:30 | |
| Esc=RESET | OK=LIST |

If several faults are present, the number of faults is displayed at the top of the screen.

The faults list can be accessed by pressing OK (of the scrolling and selection wheel) (examples below)

| | | |
|--|---------|-----|
| FAULTS | | |
| [1/2] | | |
| FAULT 25/12/05 15:30 Emergency Stop | | |
| ALARM 25/12/05 15:30 Low Fuel Level | | |
| ↶ | OK=HELP | Esc |

Press Esc to return to the previous screen.

Press OK to go to the HELP screen (help on the highlighted fault)

Use the scrolling and selection wheel to scroll through the list of faults.

| | |
|--|--|
| HELP | |
| Check: - Emerg. Stop Pos. - Connector(s) | |
| Esc | |

If the alarm is no longer active, it is reset automatically (cause disappears).

Press Esc to reset a fault:

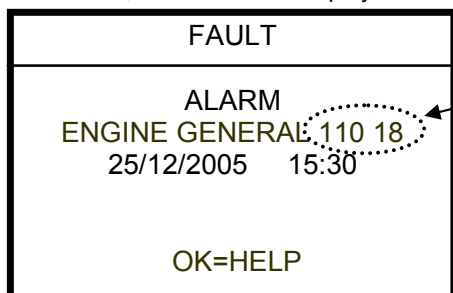
- reset acknowledged if the cause of the fault has been removed
- reset not performed if the cause of the fault is still present.

6.2.4.4. Engine fault codes display

Certain alarms and engine faults generate specific fault codes. These codes are standardised according to the J1939 and/or J1587 standards, except for MTU engines that have a specific transmission protocol (see appendix, if applicable).

| Terminology used by the SAE CAN J1939 standard | |
|--|---|
| SPN: Suspect Parameter Number | This represents the system or component at fault, for example: SPN 100, indicates an oil pressure problem or a problem with the oil pressure sensor. |
| FMI: Failure Mode identifier | This represents the type of fault that has occurred. This may be an electrical, mechanical or equipment fault. |
| Terminology used by VOLVO | |
| SID: System Identifier | This term, used in the J1587 standard, has an equivalent in the J1939 standard (SPN). However, this term corresponds, more particularly, to an assembly of components, for example, the injection system. |
| PID: Parameter Identifier | This term, used in the J1587 standard, has an equivalent in the J1939 standard (SPN). However, this term corresponds, more particularly, to a specific component, for example, a sensor. |
| PPID: Parameter Identifier | This term, used in the J1587 standard, has an equivalent in the J1939 standard (SPN). PPID corresponds to PID, but is only used by VOLVO. |
| FMI: Failure Mode identifier | This represents the type of fault that has occurred. This may be an electrical, mechanical or equipment fault. VOLVO uses a SID-FMI or PID-FMI or PPID-FMI combination. |
| Terminology used by PERKINS | |
| CID: Component parameter | This term used by PERKINS has an equivalent in the J1939 standard (SPN). |
| FMI: Failure Mode identifier | This represents the type of fault that has occurred. This may be an electrical, mechanical or equipment fault. |
| Terminology used by JOHN DEERE | |
| SPN: Suspect Parameter Number | This represents the system or component at fault, for example: SPN 100, indicates an oil pressure problem or a problem with the oil pressure sensor. |
| FMI: Failure Mode identifier | This represents the type of fault that has occurred. This may be an electrical, mechanical or equipment fault. |
| Terminology used by MTU | |
| Displaying faults | The ADEC and MDEC general system faults are indicated on the equipment in the following way: fault code numbers (generated by the ECU - Engine control unit). |

In the event of a fault, the screen will display the following message:



Engine fault code.

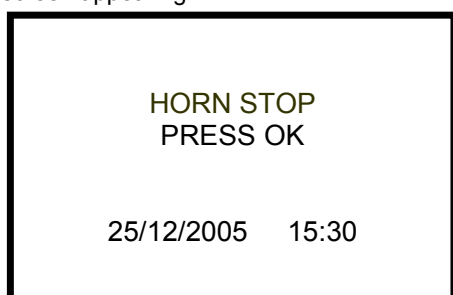
Pressing OK will display fault finding information.

In addition, appendix D indicate the meaning of the code. The checking and maintenance operations to carry out in order to solve the fault are included in the user and maintenance manuals of the engines supplied with the generating set documentation.

For JOHN DEERE (JD), PERKINS (PE) and VOLVO (VO) engines, the codes displayed are SPN and FMI codes.

6.2.4.5. Horn reset

Depending on the settings made (menu 363 - HORN), the activation of an alarm and/or a fault leads to the horn sounding and the following screen appearing:



This screen will display first any messages relating to the alarms and faults that appear as soon as OK is pressed.

6.3. Generator set with KERYS control panel

6.3.1 Presentation of the KERYS

The MICS Kerys system consists of a set of electronic modules in which each module performs a specific function..

These modules are interconnected according to a very precise architecture and exchange data to allow the following: the command, control, regulation and protection of one or more generating sets according to multiple configurations.

The configurations range from the so-called "solo" generating set, with or without source inverter, to generating sets coupled to each other, enabling electrical power plants to be created that can be coupled to one or more distribution grids in low voltage (LV) and medium voltage (MV).

The MICS Kerys system consists of the following modules:

- man/machine interface module, also called MMI module,
- base module (heart of the system),
- regulation module,
- protection module,
- logic input/output module,
- analogue input/output module,
- temperature input module.

For the operation of a generating set in the smallest possible architecture, at least the following elements will be found:

- a man/machine interface module,
- a base module,
- a regulation module.

6.3.1.1. Operating conditions

- | | |
|---------------------------------------|---|
| ✓ Operating temperatures: | - 20 °C ⇔ + 70 °C |
| ✓ Storage temperatures: | - 20 °C ⇔ + 70 °C |
| ✓ Relative humidity during operation: | 10 % to 95 % without condensation according to IEC 1131-2 and equivalent UL/CSA |
| ✓ Relative humidity during storage: | 5 % to 95% without condensation according to IEC 1131-2 and equivalent UL/CSA |
| ✓ Height: | 2,000 m during operation (Transfer 3,000 m) |
| ✓ Degree of protection: | - Outside cabinet: IP54 (front of MMI modules). - Inside cabinet: IP20 (BASE, ESTOR, ESANA, ETEMP, back of the MMI). |
| ✓ Mechanical strength: | Free falls (with packing), 5 random falls of: 1 m if p< 10 kg 0.5 m from 10 to 40 kg 0.25 m >40 kg |

6.3.1.2. Conformity to legal and regulatory requirements

The various components of the system comply with the following standards:

- ✓ Requirements specific to programmable controllers:
(Functional characteristics, immunity, robustness, safety, etc.)
⇒ EN 61131-1/2/3 (IEC 1131-2, IEC 664), EN61326,
⇒ CSA 22-2,
⇒ UL508.
- ✓ Compliance with European directives (low voltage, electromagnetic compatibility, machinery). **CE marking** in application of the safety requirements of standard EN 61131-2 – Programmable controllers, Part 2 – Equipment requirements and tests.
To obtain the specific information prescribed by EN 61131-2, refer to the appropriate sections of that publication.
- ✓ Electrical and self-extinguishability properties of insulating materials:
⇒ UL 746C,
⇒ UL 94.
- ✓ Pollution degree: 2
- ✓ Mechanical strength (details):
Vibration resistance: EN 61131-2 1994 (§2.1.3.2),
Frequency range: 10 - 57 Hz,
Continuous vibrations: 0.0375mm amplitude,
Occasional vibrations: 0.075mm amplitude.

Frequency range: 57Hz - 150Hz,
Continuous: 0.5 g constant acceleration,
Occasional: 1 g constant acceleration.
Complies with standard IEC 68-2-6, test Fc

Shock resistance
Occasional shocks: 15g, 11ms, semi-sinus.
Complies with standard IEC 68-2-27, test Fa
- ✓ Emissions: Complies with standard EN55022 class A
- ✓ Variation in supply voltage: EN61131-2 §6.3.7.3
- ✓ Immunity:
Complies with standard IEC 61000-4-2: Electrostatic discharge: 4 kV for contact discharge, 8 kV for air discharge.
Complies with standard IEC 61000-4-3: Radiated field at 10V/m from 80MHz to 1GHz with sinusoidal modulation AM 1kHz.

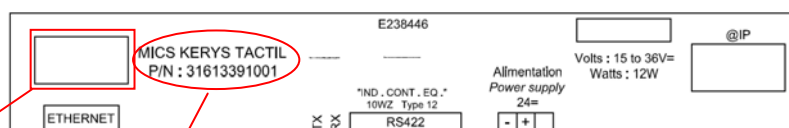
Complies with standard IEC 61000-4-4: Rapid transients in waves of 2 kV on power cables, 1 Kv on signal cables.
Complies with standard IEC 61000-4-5: Shock waves of 2 kV between wires and ground, 11 kV between wires for the supplies and 1kV relative to ground for long signal circuits (lines from a building or from a distance of over 30 m).

Complies with standard IEC 61000-4-6: Immunity to current injected at 3V from 150 kHz to 80 MHz (could be increased to 10V).
Complies with standard IEC 61000-4-8: Immunity to the magnetic field at the grid frequency at 30 A/m.

6.3.2 Description of the KERYS

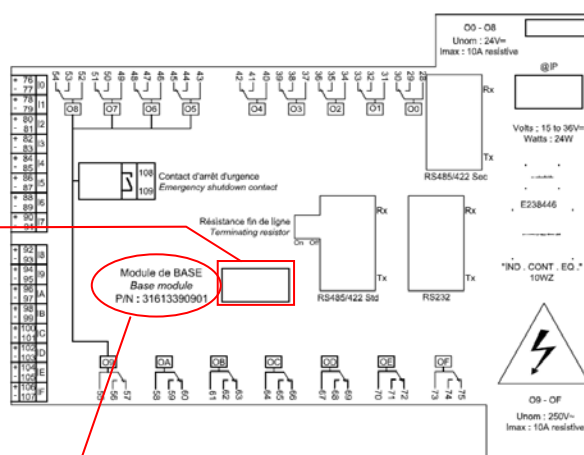
6.3.2.1. Identification of the hardware components

KERYS Tactil MMI module



| MMI Module | |
|-------------------------|--|
| P/N: 31613391001 | Module item reference |
| D346000/B1 | D346000 : manufacturer product reference B1 : module hardware upgrade index |
| S/N: 1800 | 1800 : serial number "not related" with a batch number (1800 = the 1800 th module manufactured since the start) |
| BATCH No.: 08/06 | 08 : year of manufacture (year 2008) 06 : week of manufacture (week 6) |

Base module

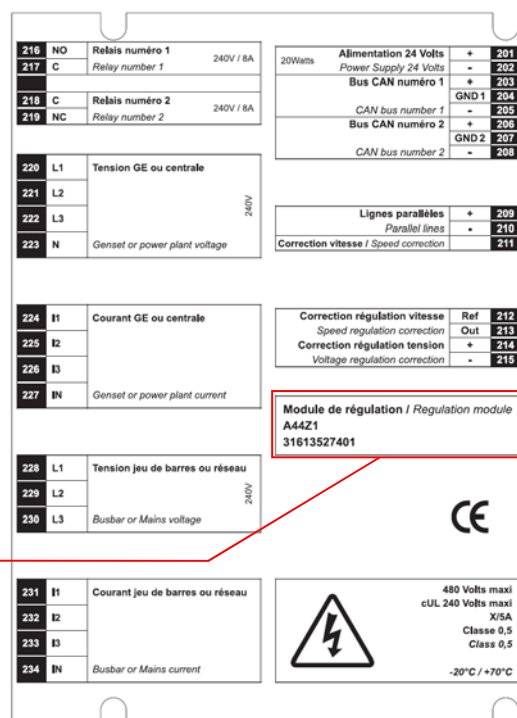


| Base module | |
|-------------------------|--|
| P/N: 31613390901 | Module item reference |
| D338000/B8 | D338000 : manufacturer product reference B8 : Module hardware upgrade index |
| S/N: 3491 | 3491 : serial number "not related" with a batch number (3491 = the 3491 st module manufactured since the start) |
| BATCH No.: 07/45 | 07 : year of manufacture (year 2007) 45 : week of manufacture (week 45) |

Regulation module

| Regulation module | |
|-------------------|--|
| 31613391501 | Module item reference |
| A44Z1-G | A44Z1: manufacturer product reference G: "main" module hardware upgrade index |
| 0408A519 | 04: week of manufacture (week 4) 08: year of manufacture (year 2008) A: "secondary" module hardware upgrade index 519: serial number "related" with a batch number (*) (519 = the 519 th module manufactured in week 04 of the year 2008) |

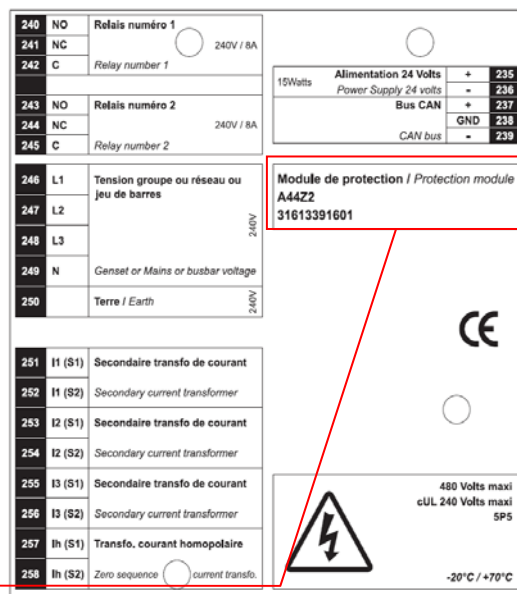
(*) i.e. a maximum of 999 modules that can be related with a batch number.



Protection module

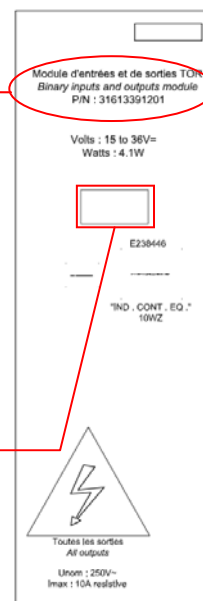
| Protection module | |
|-------------------|--|
| 31613391601 | Module item reference |
| A44Z2-E | A44Z2: manufacturer product reference E: "main" module hardware upgrade index |
| 4307A035 | 43: week of manufacture (week 43) 07: year of manufacture (year 2007) A: "secondary" module hardware upgrade index 035: serial number "related" with a batch number (*) (035 = the 35 th module manufactured in week 04 of the year 2008) |

(*) i.e. a maximum of 999 modules that can be related with a batch number.



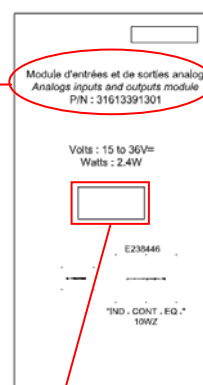
Logical inputs and outputs module

| Logical inputs and outputs module (ESTOR – Binary inputs and outputs) | |
|---|--|
| P/N : 31613391201 | Module item reference |
| D341000/B1 | D341000 : manufacturer product reference B1 : module hardware upgrade index |
| S/N: 0250 | 0250 : serial number "not related" with a batch number (0250 = le 250 th module manufactured since the start) |
| Batch No.: 06/49 | 06 : year of manufacture (year 2006) 49 : week of manufacture (week 49) |



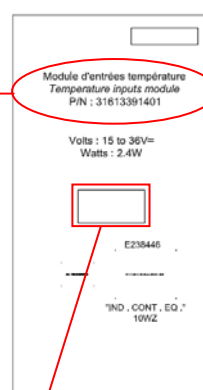
Analogue inputs and outputs module

| Analogue inputs and outputs module (ESANA) | |
|--|---|
| P/N: 31613391301 | Module item reference |
| D343000/B1 | D343000 : Manufacturer product reference B1 : module hardware upgrade index |
| S/N: 0200 | 0200 : serial number "not related" with a batch number (0200 = the 200 th module manufactured since the start) |
| BATCH No.: 06/49 | 06 : year of manufacture (year 2006) 49 : week of manufacture (week 49) |



Temperature inputs module

| Temperature inputs module (ETEMP) | |
|-----------------------------------|---|
| P/N: 31613391401 | Module item reference |
| D344000/B1 | D344000 : manufacturer product reference B1 : module hardware upgrade index |
| S/N: 0150 | 0150 : serial number "not related" with a batch number (0150 = the 150 th module manufactured since the start) |
| BATCH No.: 06/49 | 06 : year of manufacture (year 2006) 49 : week of manufacture (week 49) |



6.3.2.2. Identification of the software components

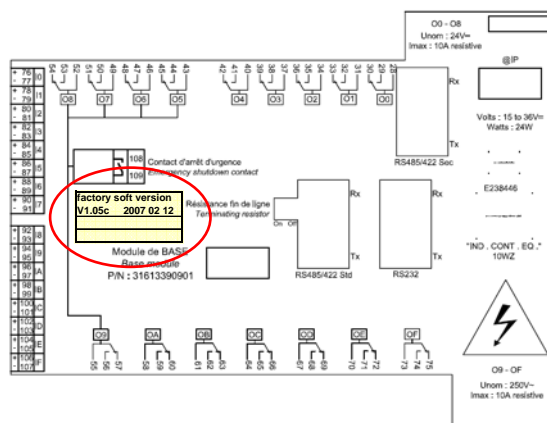
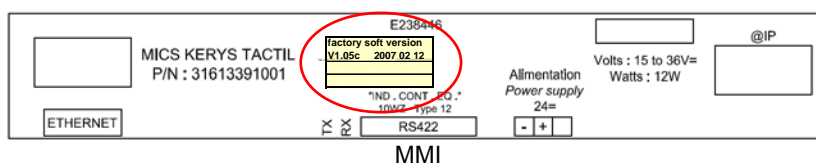
Only the components base module, MMI module, regulation module and protection module have embedded software. "Software version" is referred to in order to identify a program implemented in one of the components.

| | |
|-------------------|--|
| V1.05c1 | V: as software version 1.05 : is the revision, which is a combination of 3 digits c : main revision index 1 : secondary revision index used for specific projects |
| 2007_02_12 | Date of software version in English (year, month, day). |

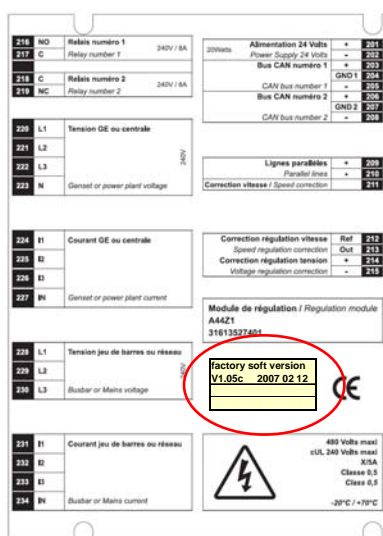
For a modification of a software version during the life of one of the products (developments, corrections, etc.), the new software version implemented will be entered by hand in a space reserved for this. The old software version will then be deleted.

factory soft version
V1.05c 2007 02 12

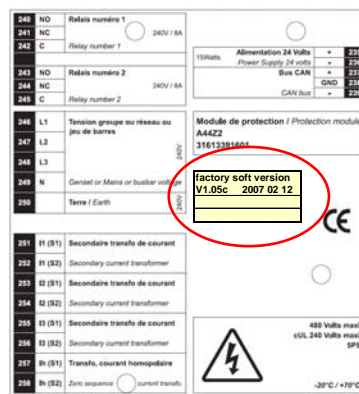
Location of the version labels



Base module



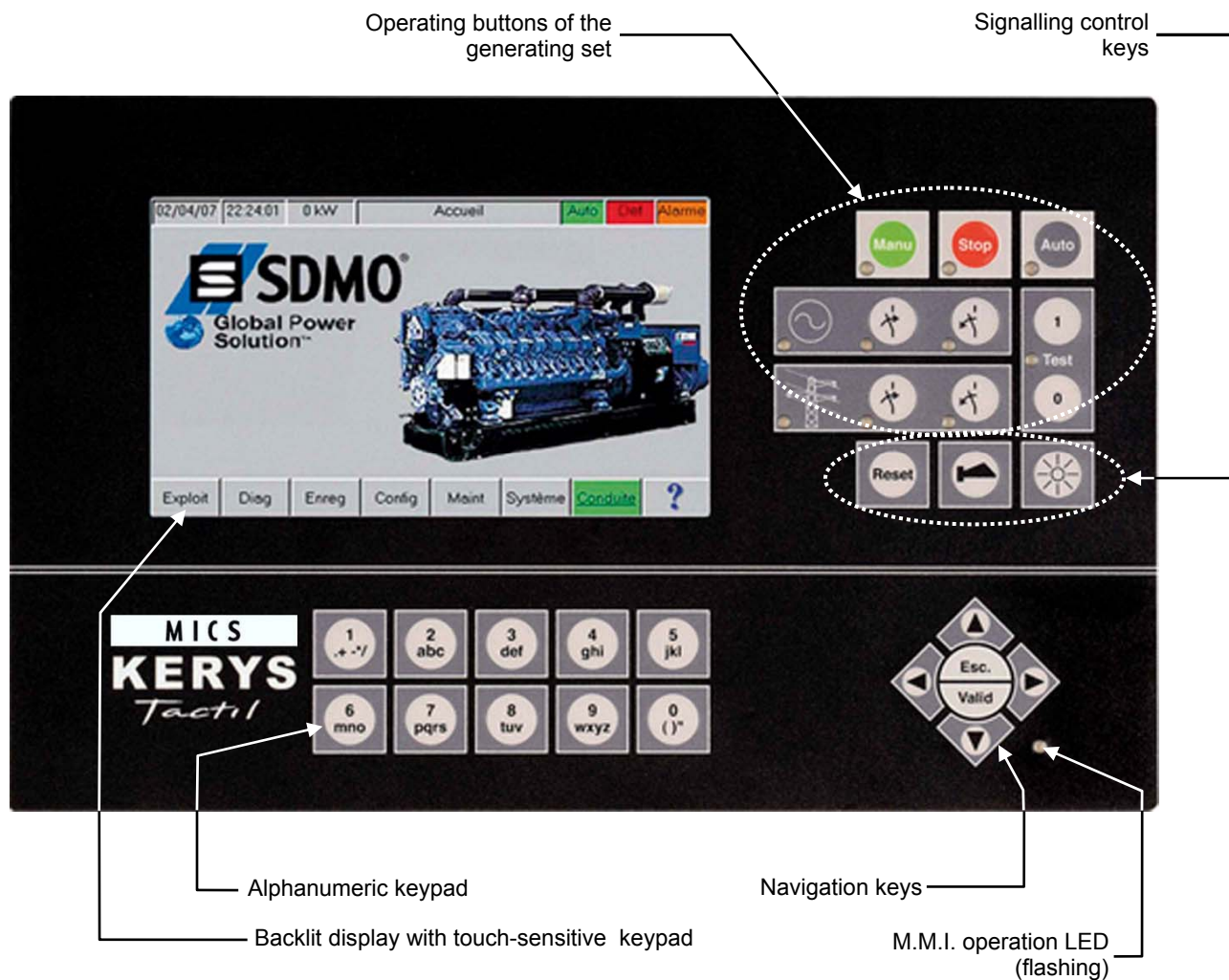
Regulation module



Protection module

6.3.3 Description of the Man Machine Interface (IHM/MMI)

6.3.3.1. The Man Machine Interface

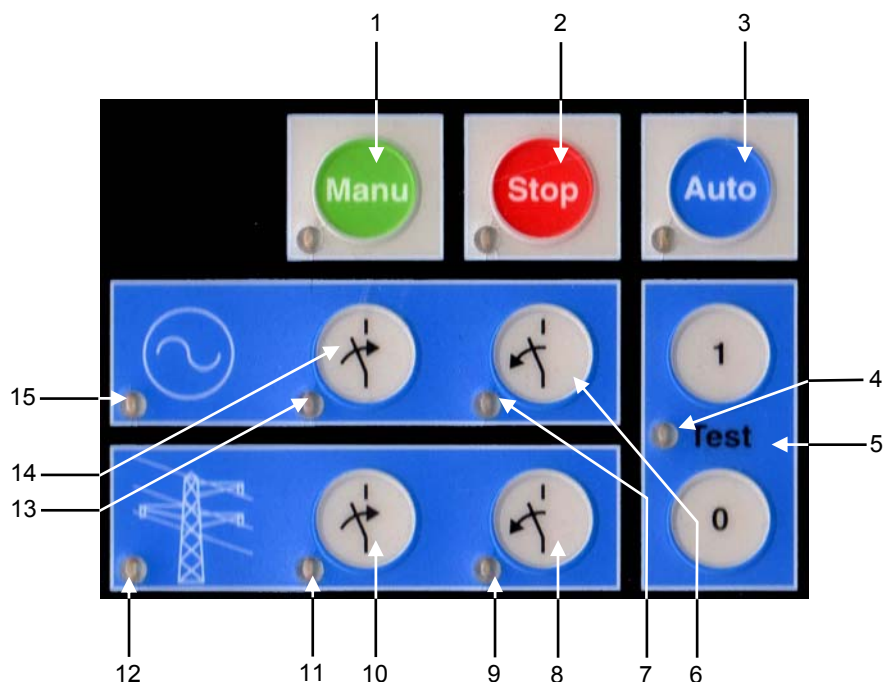


Display

The display has the following specifications:

- 7-inch colour TFT display, 16/9, 65536 colours
- dimensions: 154 mm x 86 mm
- neon backlighting
- 480 x 234 resolution
- touch panel (8 columns x 8 rows).

The generating set operational keys




- 1 Manual mode selection. The illuminated led indicates that the mode is active
- 2 Selecting stop mode. The illuminated led indicates that the mode is active
- 3 Automatic mode selection. The illuminated led indicates that the mode is active
- 4 Test in progress LED.
- 5 In auto mode: test sequence control (off load test / load test) (*)
In manual mode: engine start-up and stop
- 6 Generating set circuit breaker opening control
- 7 Led indicating that generating set circuit breaker is open
- 8 Grid circuit breaker opening control
- 9 Led indicating that grid circuit breaker is open
- 10 Grid circuit breaker closing control
- 11 Led indicating that grid circuit breaker is closed
- 12 Led indicating the presence of grid voltage
- 13 Led indicating that grid circuit breaker is closed
- 14 Closing control for generating set circuit breaker
- 15 Led indicating the presence of generating set voltage


(*) The test request brings up a screen which offers a choice between “load test” and “off load test”.

The signalling control keys




The  key clears the faults.



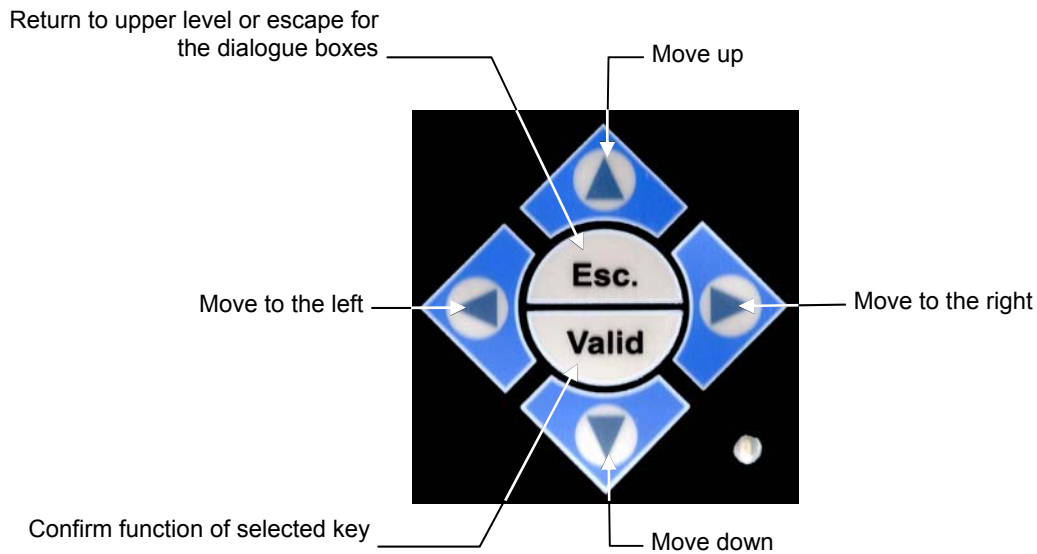
The  key stops the buzzer.



The  key commands testing of the LED's on the front of the MMI.

The navigation keys

It is also possible to navigate through the menus using the keypad.



It is possible to gain direct access to a menu by pressing the numerical key corresponding to its name.

The alphanumeric keys

They allow alphanumeric input by successive pressing of the keys. The characters entered appear in the order they were typed on the keypad.



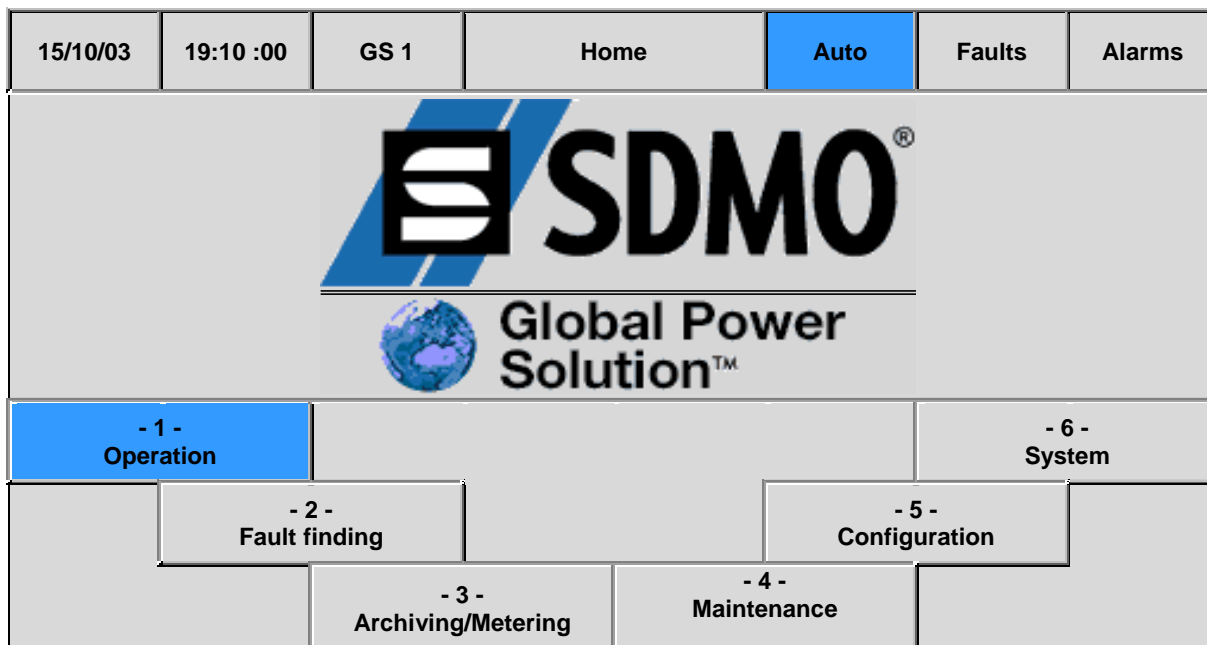
6.3.3.2. Navigation in the screens

There are three types:

- the home screen,
- the navigation screens,
- the operation and configuration screens.

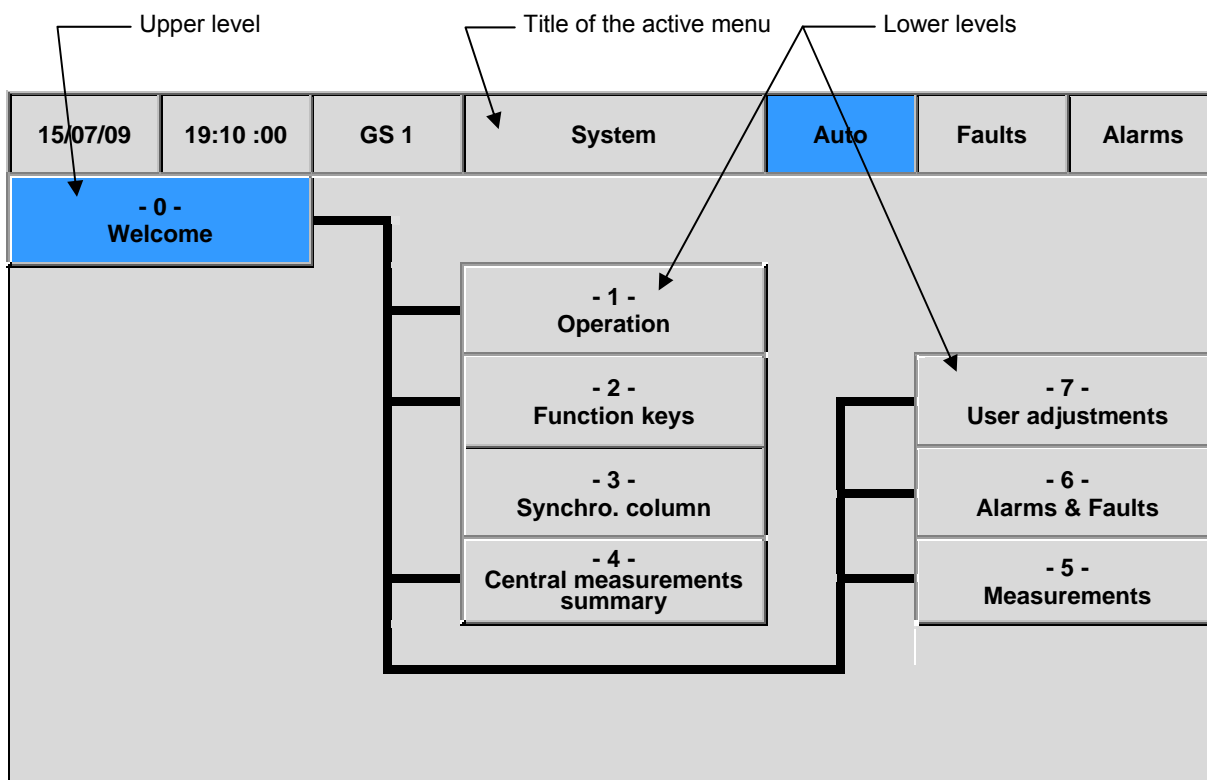
Home screen

This screen is the entry point to the system. It enables the main functions of the navigation to be accessed.



Navigation screens

These screens enable the various sub-menus to be accessed.



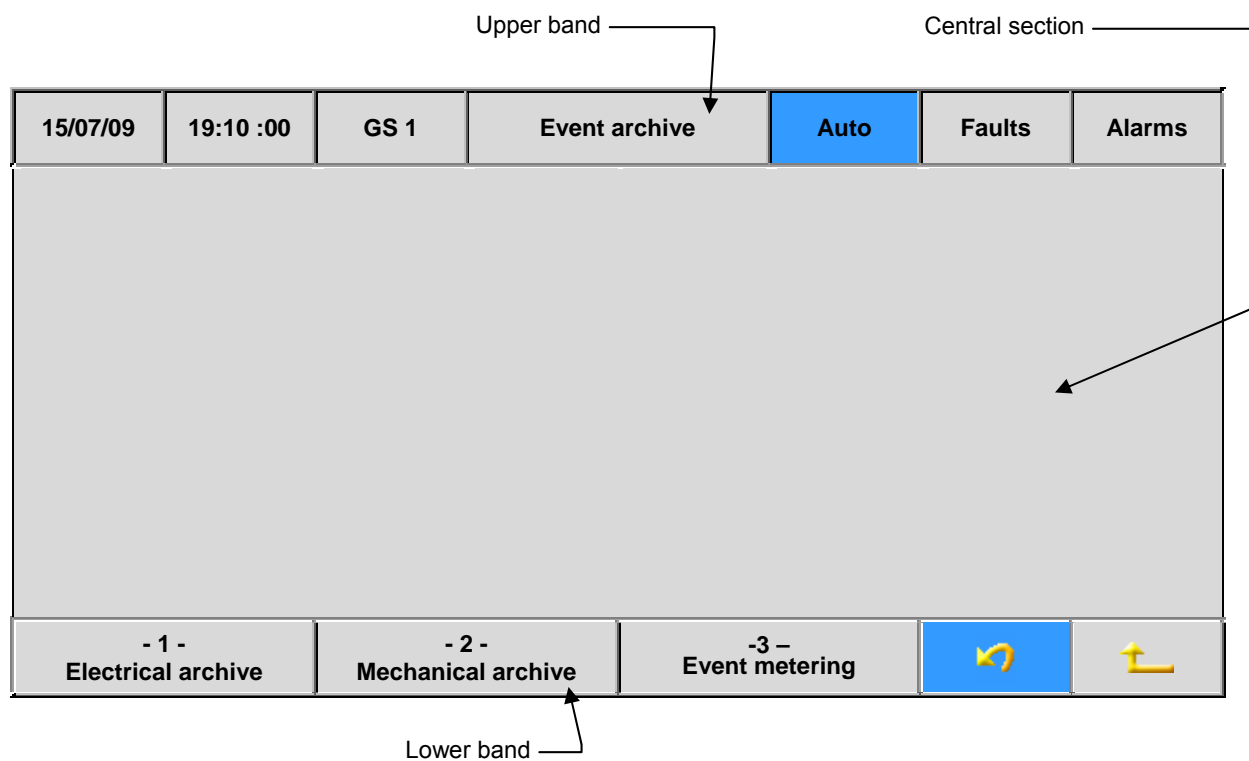
When a key is selected the lower level sub-menu appears if available or the allocated operation screen.
 A sub-menu can also be accessed by pressing the corresponding key.
 E.g.: by pressing key "1" on the alphanumeric keypad, you can directly access the "Operation" screen.

The operating and configuration screens

These screens bring up the information and commands relating to the active menu.

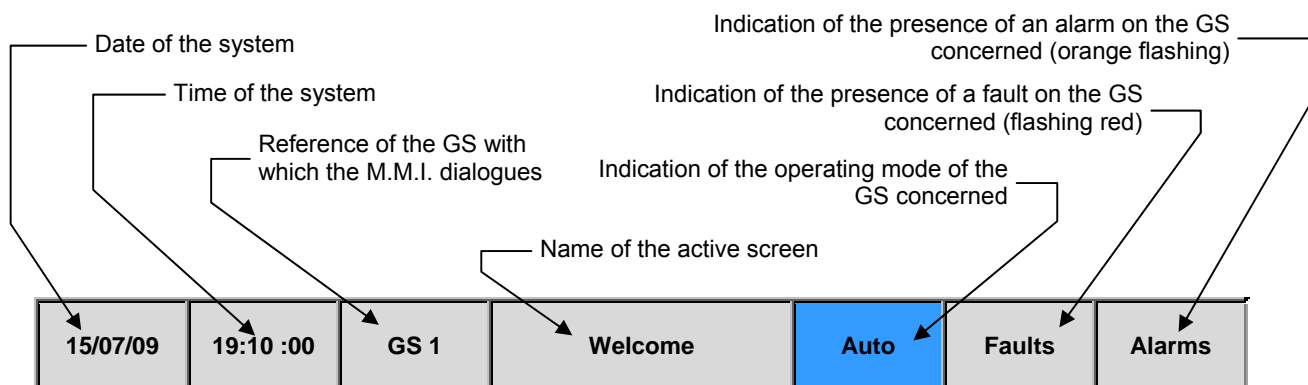
They are divided into three zones:

- an upper band common to all types of screens.
- the central section in which the specific information on the selected menu appears.
- a lower band.

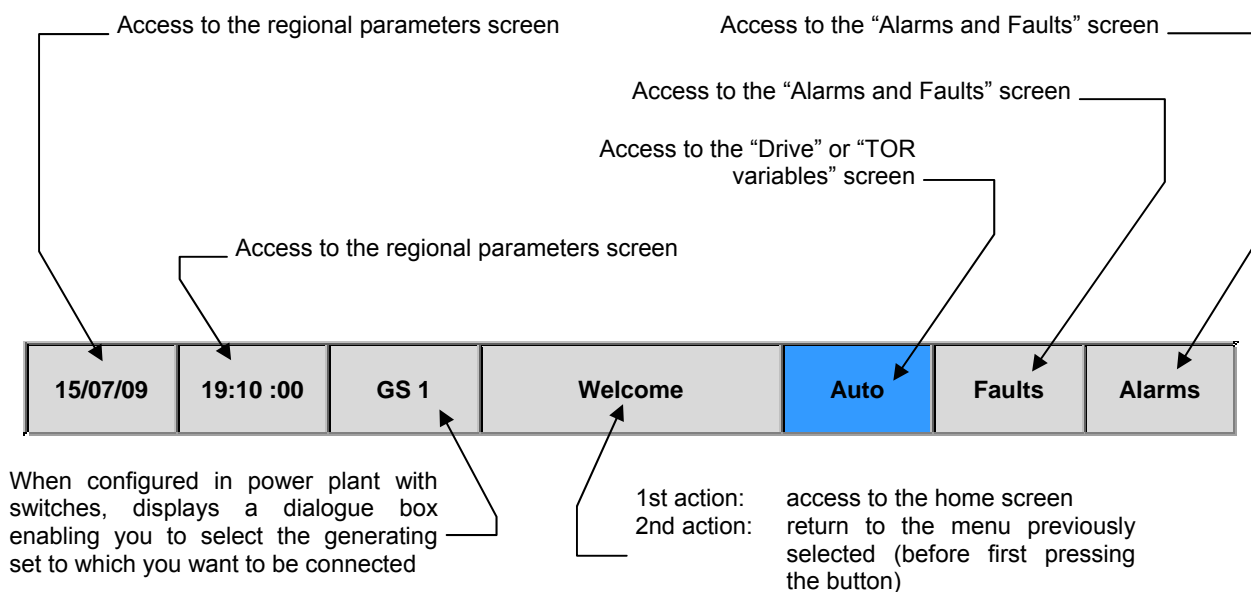


Upper band

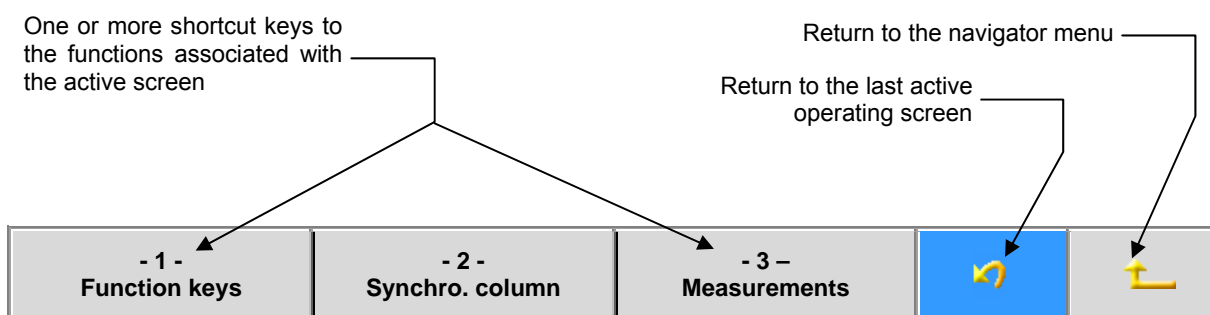
Indications



Controls



Lower band



The registration dialogue box

The registration dialogue boxes

To facilitate the entry of the information (parameters, texts), there are special screens, called "dialogue boxes", which appear when the need arises.

Confirmation of an entry in a menu

After the modification of a value in a menu the following dialogue box appears:

Validation

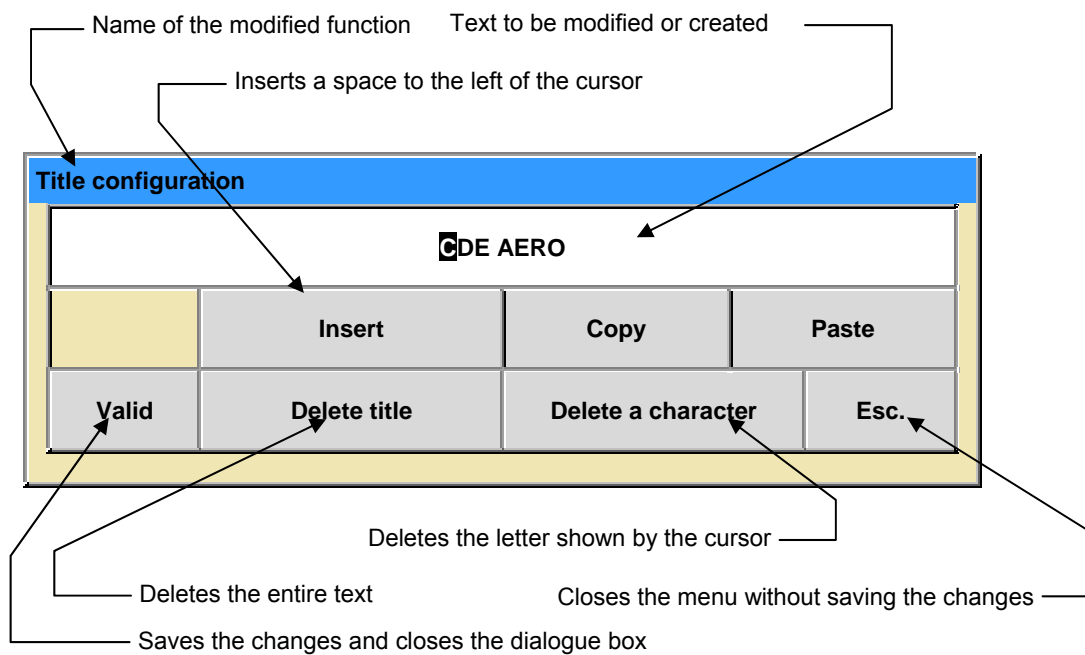
Validation of data entered

Valid

Esc.

The confirmation key "**Valid**" saves the modification, the escape key "**Esc.**" cancels the modification.

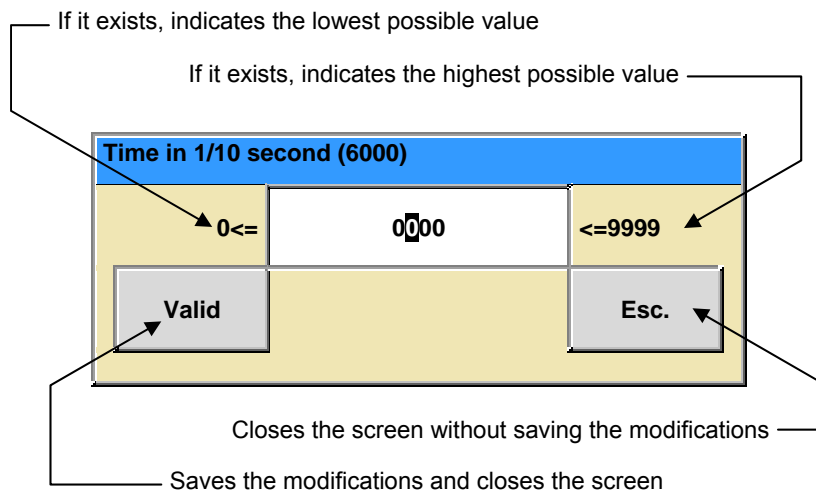
Entry of a text



You move within the text using the “right” or “left” arrows on the keypad.
The characters are entered by means of the alphanumeric keys on the keypad.

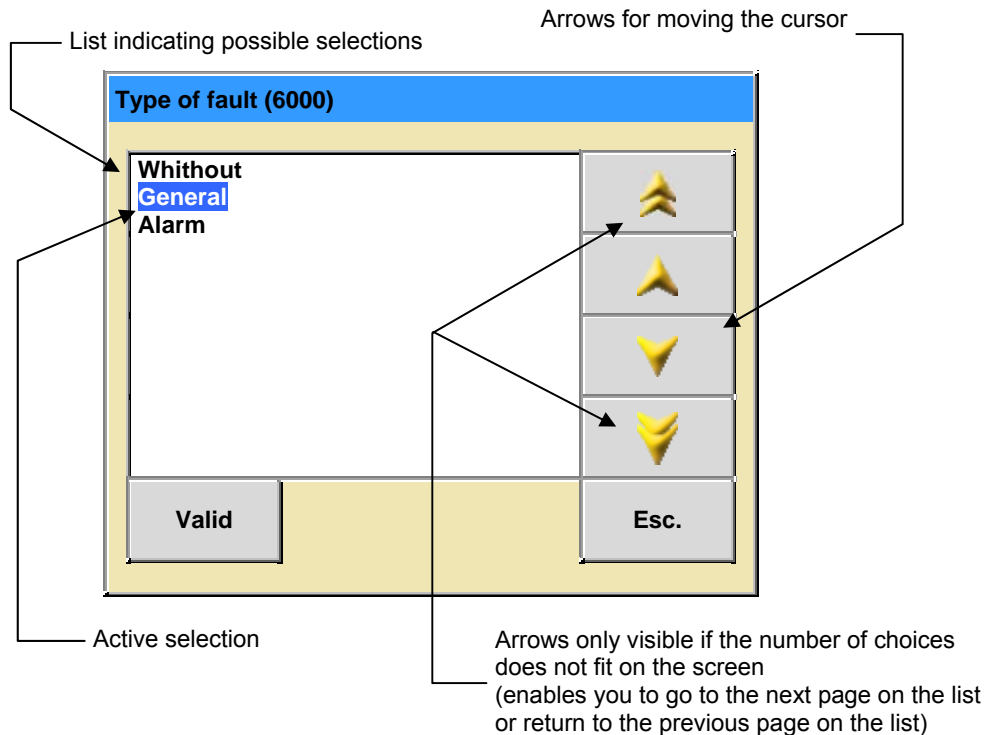
Entering numerical values

The heading of the box provides information on the type of value entered, its unit and the variable concerned.
These indications are linked to the type of modified parameter.



Selecting from a list

The box heading indicates the parameter which will be assigned from your selection.



Saving changes

After changing a parameter, the new data is stored in volatile memory, which means that in the event of a power failure, any changes will be lost. It is also necessary to transfer these values to permanent memory. This is the "Save in flash" operation. Following a modification a red "Sauvegarde à faire" (Save) indicator light flashes at the top left of the screen. Pressing this indicator light brings up one of the following dialogue boxes:

Save in flash

Valid

Esc.

Save in flash

Customer

Factory

☒
☐

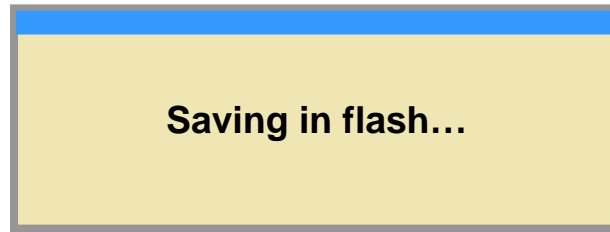
Valid

Esc.

Always select "Client"

Pressing "Valid" confirms the operation, pressing "Esc." cancels it.

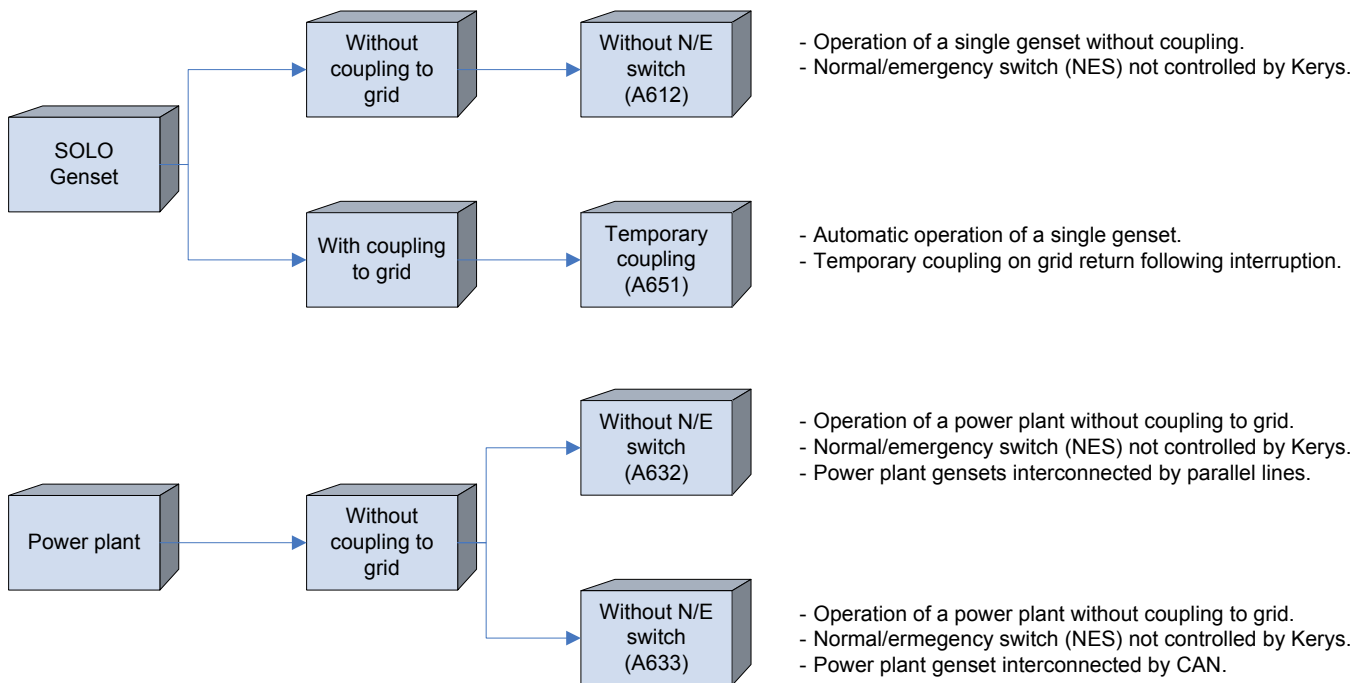
During saving, the following screen indicates that the operation in is progress:



6.3.4 Configurations

6.3.4.1. Operating principle

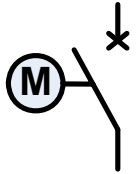


The operational modes are as follows:



Note:

Without coupling: the switch is equipped with electrical and mechanical interlocking.
 With coupling: the switch is not equipped with an electrical and mechanical interlock.

6.3.4.2. Legends

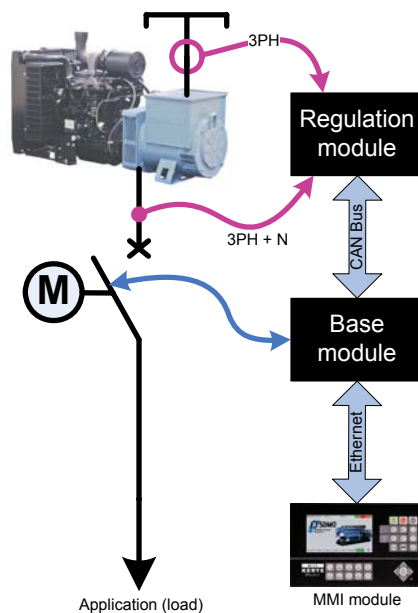
| | |
|---|--|
|  | Electrically controlled circuit breaker |
|  | Exchange of information from A to B and from B to A |
|  | Transmission of information from A to B only |
| 3 PH | "Current" information, 3 PH = 3 phases |
| 3 PH + N | "Voltage" information, 3 PH + N = 3 Phases + Neutral |

6.3.4.3. Configuration in solo generating set

Without Normal/Emergency inverter (A612)

This configuration is designed to provide:

- ✓ The generation of electricity for an installation from an external starting command (dry contact).
- ✓ The generation of electricity for an installation in forced operation.



Automatic operation (Kerys in "AUTO" mode)

Loss of grid voltage

- Generating set start request (dry contact, switch, clock, etc.).
- The speed and voltage of the generating set increase.
- Generating set power unit switched off after voltage and frequency stabilisation.

Return of grid voltage

- Dry contact, switch, clock, etc. switched on.
- Cooling delay.
- Generating set stopped and set to standby.

FORCED OPERATION (Kerys in “AUTO” mode)

Start of FORCED OPERATION

- Generating set start request (dry contact, switch, clock, etc.).
- The speed and voltage of the generating set increase.
- Generating set power unit switched off after voltage and frequency stabilisation.

The installation is supplied by the generating set

End of FORCED OPERATION

- Dry contact, switch, clock, etc. switched on.
- Generating set power unit switched on.
- Cooling delay.
- Generating set stopped and set to standby.

The Kerys remains in “AUTO” mode

Manual operation of generating set

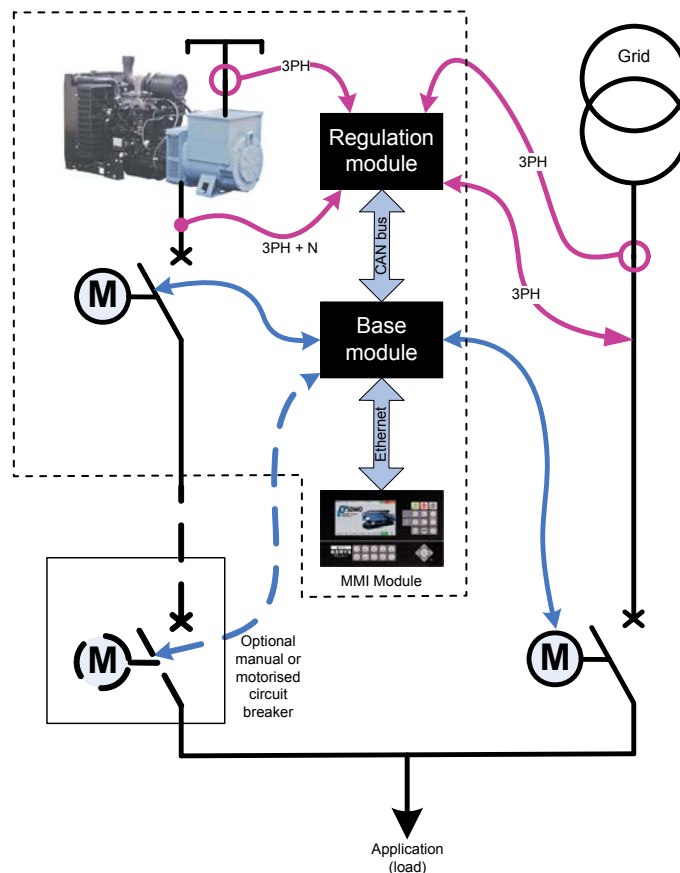
This mode of operation is selected with the “MANU” key (on the front of the MMI module). The operator is able to start and stop the generating set by using the MMI keypad. The generating set power unit is switched off by means of the MMI keys. The safety devices of the generating set remain active in this mode of operation.

This mode of operation is the responsibility of the operator.

Temporary coupling to the grid (A651)

This configuration is designed to provide:

- ✓ Emergency electricity supply to an installation following a grid loss. Return to the grid is achieved by a temporary coupling with transfer of the generating set load to the grid.
- ✓ FORCED OPERATION with a generating set.
- ✓ Temporary coupling for “Effacement Jour de Pointe” (EJP)* mode or other rates (Information transmitted by dry contacts).



* the “EJP” (Peak Day Load Shedding) system is specific to the French power grid.

Automatic operation (Kerys in “AUTO” mode) (temporary “grid return” coupling)

Loss of grid voltage

- Adjustable grid loss acquisition delay (controlled by the Kerys or by a mains detection module).
- Generating set start request.
- The speed and voltage of the generating set increase.
- Power unit switched on, grid side.
- Generating set power unit switched off after voltage and frequency stabilisation.

Return of grid voltage

- Adjustable grid return acquisition delay (controlled by the Kerys or by a mains detection module).
- Synchronisation of the generating set to the grid.
- After synchronisation, the grid power unit is switched off.
- Transfer of the active and reactive power of the generating set to the grid according to a predetermined ramp. The ramp does not exceed 10 seconds for transfer of the generating set's rated output. The generating set power unit is disconnected when the power on the generating set reaches the lower limit.
- Generating set power unit switched on.
- Cooling delay.
- Generating set stopped and set to standby.

The Kerys remains in “AUTO” mode

FORCED OPERATION (Kerys in “AUTO” mode) (temporary outward and return coupling)

Start of FORCED OPERATION

- Generating set start request.
- The generating set voltage and speed increase.
- When the generating set is stabilised in speed and voltage, synchronisation of the generating set to the grid is requested.
- After synchronisation, the generating set power unit is switched off.
- Transfer of the active and reactive power from the grid to the generating set according to a predetermined ramp. The ramp does not exceed 10 seconds for transfer of the generating set's rated output. The generating set power unit is disconnected when the power on the generating set reaches the lower limit.
- Power unit switched on, grid side.

The installation is supplied by the generating set

End of FORCED OPERATION

- Opening of the forced operation order.
- Synchronisation of the generating set to the grid.
- Grid power unit switched off.
- Transfer of the generating set's active and reactive power to the grid.
- Generating set power unit switched on.
- Cooling delay.
- Generating set stopped and set to standby.

***The Kerys remains in “AUTO” mode
The installation is supplied by the grid***

Manual generating set operation

This mode of operation is selected with the “MANU” key. The operator is able to start and stop the generating set via the MMI keypad. The power unit is switched off manually with the manual synchronisation of the generating set to the grid using the keys “+ F”, “- F”, “+V”, “-V”, the load transfer remains automatic. The safety devices of the generating set remain active in this mode of operation.

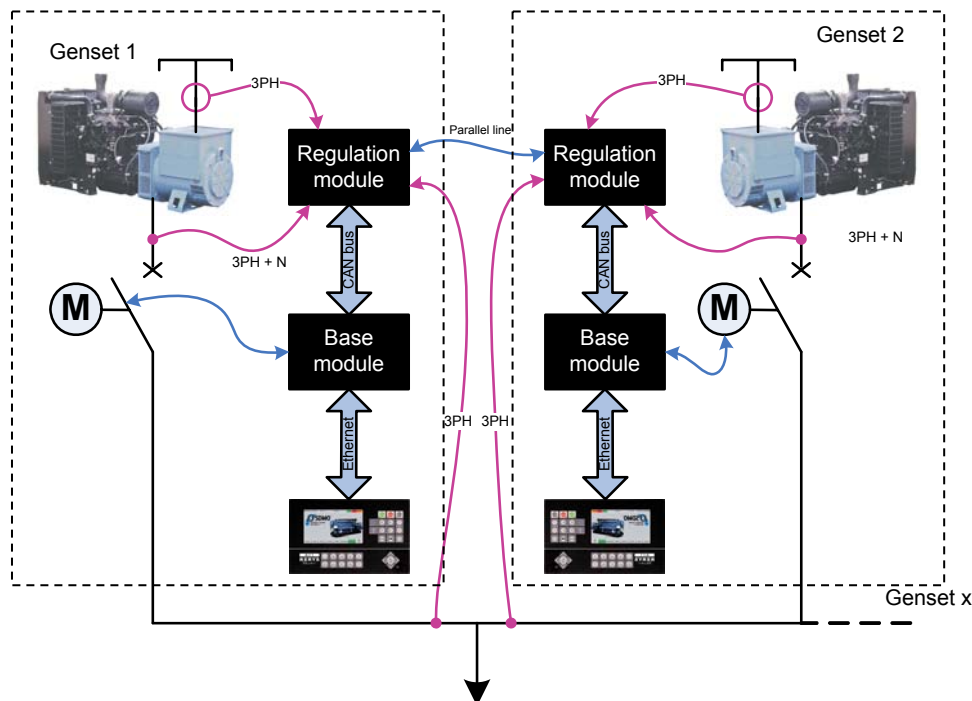
This mode of operation is the responsibility of the operator

6.3.4.4. Power plant configuration (Several generating sets in parallel)

Without common part and without Normal/Emergency inverter (A632)

This configuration is designed to provide:

- ✓ Emergency electricity supply to an installation following a grid loss (The grid loss is not controlled by Kerys). Return to the grid will be achieved by Normal / Emergency switchover by means of a self-driven inverter (not controlled by Kerys).
- ✓ FORCED OPERATION with a generating set.
- ✓ Operation in "Effacement Jour de Pointe" (EJP)* mode or other rates. (Information transmitted by dry contacts).
- ✓ An active power regulation (speed of the generating sets) by parallel lines connected between all the regulation modules.



(*) the "EJP" (Peak Day Load Shedding) system is specific to the French power grid.

Note 1: In this operating mode there is no reactive power regulation (generating set voltage); the generating sets are static.

Note 2: In an installation of the power station type (several generating sets in parallel) two modes of coupling between generating sets are possible

- Coupling when stopped.
- Coupling in normal operation.

Principle of coupling when stopped

- all the generating set power units are switched off,
- starting of all the generating sets,
- when the speed reaches 1450 rpm, activated excitation command on all the generating sets,
- the voltage generated by each generating set increases gradually and the voltage is therefore the same in all generating sets,
- the generating sets therefore reach 1500 rpm at 400 V 50 Hz.

At the end of global operation, if the power consumed by the installation does not require the operation of all the generating sets within the power plant, one or more generating sets will be stopped according to the wattmetric control. Restarting of the generating set (these generating sets) depends on the load and wattmetric control of the load. However, if a generating set is reconnected to a busbar already subjected to a load, the "recoupling" is carried out in normal operation and not when the generating set is stopped.

Principle of coupling in normal operation

Coupling in normal operation enables all the generating sets to be coupled (in voltage and frequency) to a busbar supplied by a generating set designed as master at the output.

A number (1 to 15) is assigned to each Kerys. This number serves solely to establish the IP address of each Kerys for communication by Ethernet and loading the programs.

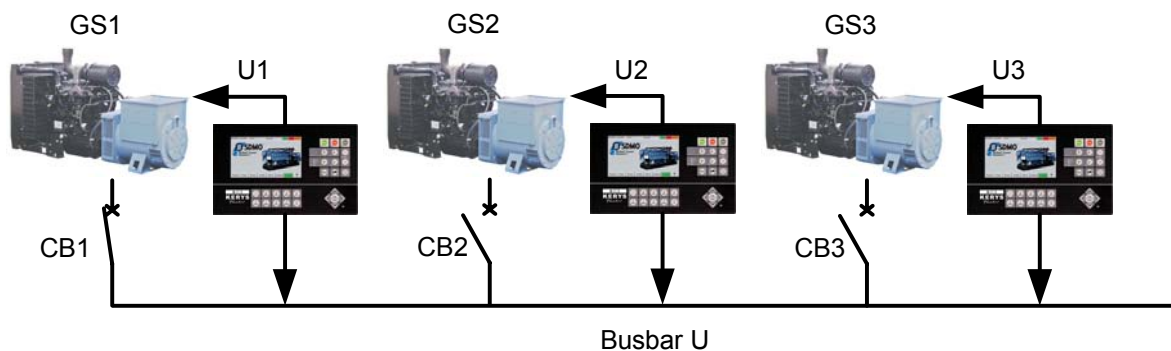
A second number (from 1 to 15) is also assigned to each Kerys and defines the priority.

Example: let us assume a plant of 8 generating sets

| | | | | | | | | |
|----------|----|----|----|----|----|----|----|----|
| Gen set | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Priority | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 |

The numbers on the first line enable the IP address of each Kerys to be allocated. The numbers on the second line define the priority.

Therefore Kerys no. 8 with priority 01 is considered to be the master generating set and closes its flow first. The other generating sets then synchronise one by one to the central busbar, transmitting the information on voltage, frequency and phase difference to this busbar (see sketch).



Example for 3 GSs:

- DJ1 (Circuit breaker 1) is closed, the voltage is present on the busbar.
- Kerys 2 analyses the differences between U2 and U of the busbar before coupling.
- Kerys 3 analyses the differences between U3 and U of the busbar before coupling.

Each Kerys, independently of its neighbour, will close its discharge on the central busbar.

Wattmetric control

The wattmetric control is used when two generating sets are coupled. It provides optimum management of the number of generating sets operating by constantly analysing the power required by the user.

Let us take the example of a power plant of 4 x 600 kW generating sets.

The threshold setting screen (1-7-3-3) supplies the following data:

| | | | | | |
|------------------------|-----|---------|------------------------|------|--------|
| Threshold 1 GS => 2 GS | 75% | 450 kW | Threshold 2 GS => 1 GS | 30 % | 360 kW |
| Threshold 2 GS => 3 GS | 75% | 900 kW | Threshold 3 GS => 2 GS | 30 % | 540 kW |
| Threshold 3 GS => 4 GS | 75% | 1350 kW | Threshold 4 GS => 3 GS | 30 % | 720 kW |

The maximum available power is $600 \times 4 = 2400$ kW. Assuming that a single generating set is operating, we will have the following sequence in the case of linear progression of the load.

When the power required by the application reaches 75% of the power of the generating set in operation (GS at priority 01), i.e. 450 kW, the second GS (at priority 02) is started and is synchronised with GS 1. Its flow is then closed.

The second GS thus coupled initiates its power on ramp (adjustable delay) and the distribution of power among the two generating sets takes place. Each generating set will then take 50% of the required power, i.e. 225 kW.

When the power required for the application reaches 75% of the power of the two generating sets in operation (GSs at priority 01 and 02), i.e. 900 kW, the third GS (at priority 03) is then started and is synchronised with GS1 and GS2. Its flow is then closed. The third GS thus coupled initiates its power on ramp (adjustable delay), and the distribution of power among the three generating sets takes place.

Each generating set will then take 33.33% of the required power, i.e. 300 kW, corresponding to 50% of its rated output (600 kW).

When the power required for the application reaches 75% of the power of the three GSs in operation (GSs at priority 01, 02 and 03), i.e. 1350 kW, the fourth GS (at priority 04) is then started and synchronised with GS1, GS2 and GS3. Its flow is then closed. The fourth GS thus coupled initiates its power on ramp (adjustable delay) and the distribution of power among the four generating sets takes place. Each generating set will then take 25% of the power required, i.e. 337.5 kW, corresponding to 56.25% of its rated output (600 kW).

The power required for the application may continue to increase up to the upper plant limit (95%) of 2400 kW, i.e. 2280 kW (the setting can be changed). This corresponds of course to the upper generating set limit, i.e. 570 kW (95% of 600 kW).

Automatic operation (All Kerys PLCs in “AUTO” mode) (coupling when stopped)

Loss of grid voltage

- Grid loss acquisition delay (controlled by the mains detection module).
- Generating set power units switched off.
- Generating set start request.
- The generating sets' speed increases.
- Speed stabilisation delay.
- Order of excitation for each generating set at nominal speed; the voltage is then quickly established on the busbar.
- Start of distribution of active power.
- Resumption of use at the rated power and frequency.

Wattmetric control

This wattmetric control will be activated after a global operation delay. This global operation enables the application to be resumed after power is restored to the different outputs, and ensures stability of the load before the wattmetric control is started.

Depending on the power for the application, the number of generating sets in production may vary in order to optimise the production for consumption.

The procedure is as follows:

- End of the global operation delay.
 - Start of analysis of the active power consumed.
- ✓ Example: A generating set must be stopped according to the set thresholds.
- Power cut at the non-priority generating set, transfer of the power to the generating set(s) remaining in production.
 - Uncoupling of the non-priority generating set, at zero power, by switching on the generating set power unit.
 - Cooling delay.
 - Generating set stopped and set to standby.
- ✓ Example of increase in power:
- Generating set start request.
 - The speed of the generating set increases.
 - Alternator excitation, the generating set establishes its voltage.
 - Request for synchronisation of the generating set to the busbar (i.e. the other coupled generating sets).
 - Generating set power unit switched off.

Return of grid voltage

- Grid return acquisition delay (controlled by the mains detection module).
- Generating set power units switched on.
- Cooling delay.
- Generating sets stopped and set to standby.

The Kerys PLCs remain in “AUTO” mode

FORCED OPERATION

Start of FORCED OPERATION

- Generating set power units switched off.
- Generating set start request.
- The generating sets increase in speed.
- Speed stabilisation delay.
- Order of excitation for each generating set at nominal speed; the voltage is then quickly established on the busbar.
- Start of active power distribution.
- Resumption of application at rated voltage and frequency.

*The Kerys PLCs remain in "AUTO" mode
The installation is supplied by the generating sets*

End of FORCED OPERATION

- Generating set power units switched on.
- Cooling delay.
- Generating sets stopped and set to standby.

*The Kerys PLCs remain in "AUTO" mode
The installation is supplied by the grid*

Manual power plant operation

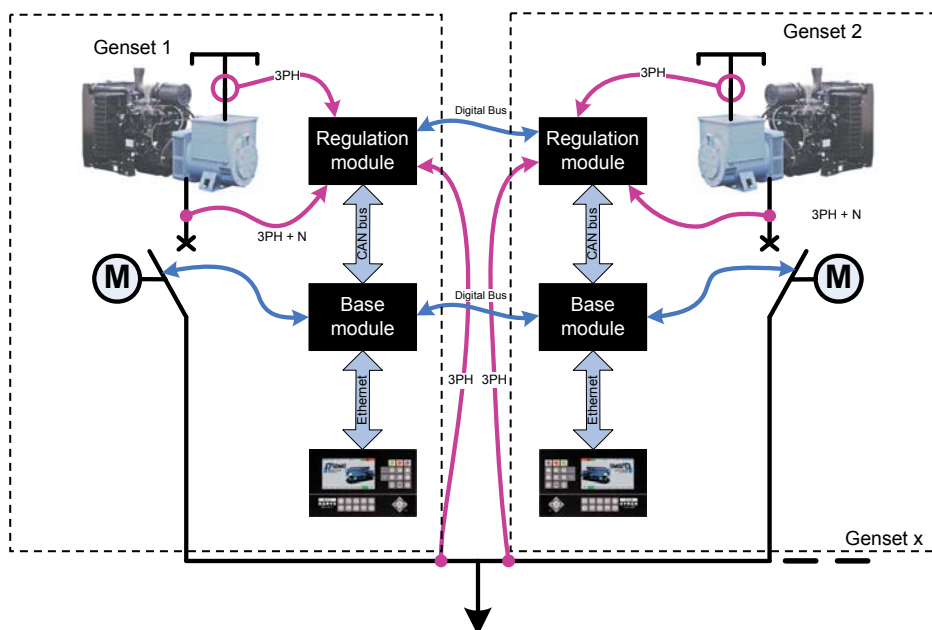
This mode of operation is selected with the "MANU" key. This enables the operator to start and stop the generating sets one by one via the MMI keypad. The generating set power unit is switched off manually with synchronisation of each generating set to the busbar using the MMI keys "+F", "-F", "+V" and "-V". The distribution of power among the generating sets remains automatic. The safety devices of the generating sets remain active in this mode of operation.

This mode of operation is the responsibility of the operator.

Without common part and without Normal/Emergency inverter (A633)

This configuration is designed to provide:

- ✓ Emergency electricity supply to an installation following a grid loss (The grid loss is not controlled by the Kerys). Return to the grid can be achieved via Normal / Emergency switchover with a self-driven inverter (not controlled by the Kerys).
- ✓ FORCED OPERATION with a generating set.
- ✓ Operation in "Effacement Jour de Pointe" (EJP)* mode or other rates. (Information transmitted by dry contacts).
- ✓ Active power regulation (speed of the generating sets) by digital buses connected between all the regulation modules.



(*) the "EJP" system is specific to the French power grid.

Note 1: In this operating mode active and reactive power is distributed by a digital bus between the regulation modules (voltage of the generating sets).

Note 2: In an installation of the power plant type (several generating sets connected by digital bus), two modes of coupling between generating sets are possible

- Coupling when stopped.
- Coupling in normal operation.

Principle of coupling when stopped

- all the generating set power units are switched off,
- starting of all the generating sets,
- when the speed reaches 1450 rpm, activated excitation command on all the generating sets,
- the voltage generated by each generating set increases gradually and the voltage is therefore the same in all generating sets,
- the generating sets therefore reach 1500 rpm at 400 V 50 Hz.

At the end of global operation, if the power consumed by the installation does not require the operation of all the generating sets within the power plant, one or more generating sets will be stopped according to the wattmetric control. Restarting of the generating set (these generating sets) depends on the load and wattmetric control of the load. However, if a generating set is reconnected to a busbar already subjected to a load, the "recoupling" is carried out in normal operation and not when the generating set is stopped.

Principle of coupling in normal operation

Coupling in normal operation enables all the generating sets to be coupled (in voltage and frequency) to a busbar supplied by a generating set designed as master at the output.

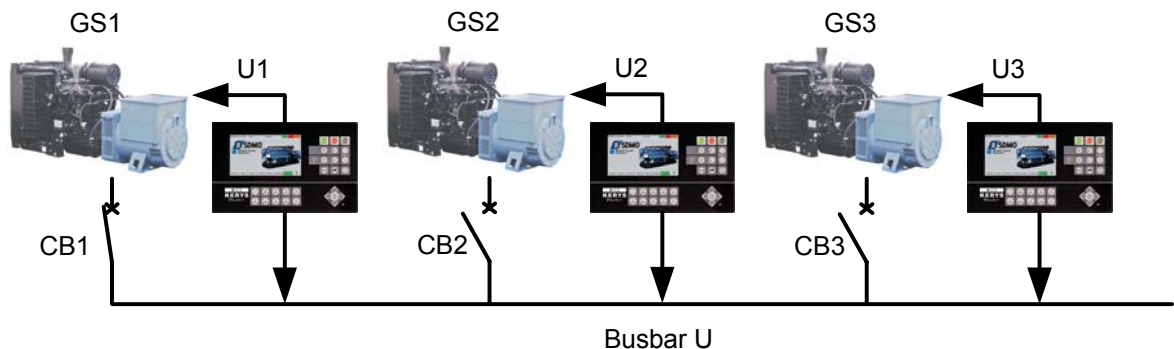
A number (1 to 15) is assigned to each Kerys. This number serves solely to establish the IP address of each Kerys for communication by Ethernet and loading the programs.

A second number (from 1 to 15) is also assigned to each Kerys and defines the priority.

Example: let us assume a plant of 8 generating sets

| | | | | | | | | |
|----------|----|----|----|----|----|----|----|----|
| Gen set | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Priority | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 |

The numbers on the first line enable the IP address of each Kerys to be allocated. The numbers on the second line define the priority. Therefore Kerys no. 8 with priority 01 is considered to be the master generating set and closes its flow first. The other generating sets then synchronise one by one to the central busbar, transmitting the information on voltage, frequency and phase difference to this busbar (see sketch).



Example for 3 GSs:

- DJ1 (Circuit breaker 1) is closed, the voltage is present on the busbar.
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- Kerys 3 analyses the differences between U3 and U of the busbar before coupling.

Each Kerys, independently of its neighbour, will close its discharge on the central busbar.

Wattmetric control

The wattmetric control is used when two generating sets are coupled. It provides optimum management of the number of generating sets operating by constantly analysing the power required by the user.

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The threshold setting screen (1-7-3-3) supplies the following data:

| | | | | | |
|------------------------|-----|---------|------------------------|------|--------|
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| Threshold 2 GS => 3 GS | 75% | 900 kW | Threshold 3 GS => 2 GS | 30 % | 540 kW |
| Threshold 3 GS => 4 GS | 75% | 1350 kW | Threshold 4 GS => 3 GS | 30 % | 720 kW |

The maximum available power is $600 \times 4 = 2400$ kW. Assuming that a single generating set is operating, we will have the following sequence in the case of linear progression of the load.

When the power required by the application reaches 75% of the power of the generating set in operation (GS at priority 01), i.e. 450 kW, the second GS (at priority 02) is started and is synchronised with GS 1. Its flow is then closed. The second GS thus coupled initiates its power on ramp (adjustable delay) and the distribution of power among the two generating sets takes place. Each generating set will then take 50% of the required power, i.e. 225 kW.

When the power required for the application reaches 75% of the power of the two generating sets in operation (GSs at priority 01 and 02), i.e. 900 kW, the third GS (at priority 03) is then started and is synchronised with GS1 and GS2. Its flow is then closed. The third GS thus coupled initiates its power on ramp (adjustable delay), and the distribution of power among the three generating sets takes place. Each generating set will then take 33.33% of the required power, i.e. 300 kW, corresponding to 50% of its rated output (600 kW).

When the power required for the application reaches 75% of the power of the three GSs in operation (GSs at priority 01, 02 and 03), i.e. 1350 kW, the fourth GS (at priority 04) is then started and synchronised with GS1, GS2 and GS3. Its flow is then closed. The fourth GS thus coupled initiates its power on ramp (adjustable delay) and the distribution of power among the four generating sets takes place. Each generating set will then take 25% of the power required, i.e. 337.5 kW, corresponding to 56.25% of its rated output (600 kW).

The power required for the application may continue to increase up to the upper plant limit (95%) of 2400 kW, i.e. 2280 kW (the setting can be changed). This corresponds of course to the upper generating set limit, i.e. 570 kW (95% of 600 kW).

Automatic operation (All Kerys PLCs in "AUTO" mode) (coupling when stopped)

Loss of grid voltage

- Grid loss acquisition delay (controlled by the mains detection module).
- Generating set power units switched off.
- Generating set start request.
- The generating sets increase in speed.
- Speed stabilisation delay.
- Order of excitation for each generating set at nominal speed; the voltage is then quickly established on the busbar.
- Start of active power distribution.
- Resumption of application at rated voltage and frequency.

Wattmetric control

This wattmetric control will be activated after a global operation delay. This global operation enables the application to be resumed after power is restored to the different outputs, and ensures stability of the load before the wattmetric control is started. Depending on the power for the application, the number of generating sets in production may vary in order to optimise the production to consumption.

The procedure is as follows:

- End of the global operation delay.
 - Start of analysis of the active power consumed.
- ✓ Example: A generating set must be stopped according to the set thresholds.
- Power cut at the non-priority generating set, transfer of the power to the generating set(s) remaining in production.
 - Uncoupling of the non-priority generating set, at zero power, by switching on the generating set power unit.
 - Cooling delay.
 - Generating set stopped and set to standby.
- ✓ Example of increase in power:
- Generating set start request.
 - The generating set increases in speed.
 - Alternator excitation, the generating set establishes its voltage.
 - Request for synchronisation of the generating set to the bus bar (i.e. the other coupled generating sets).
 - Generating set power unit switched off.
- ✓ **Return of grid voltage**
- Grid return acquisition delay (controlled by the mains detection module).
 - Generating set power units switched on.
 - Cooling delay.
 - Generating sets stopped and set to standby.

The Kerys PLCs remain in “AUTO” mode

FORCED OPERATION

Start of FORCED OPERATION

- Generating set power units switched off.
- Generating set start request.
- The generating sets increase in speed.
- Speed stabilisation delay.
- Order of excitation for each generating set at nominal speed; the voltage is then quickly established on the busbar.
- Start of active power distribution.
- Resumption of application at rated voltage and frequency.

***The Kerys PLCs remain in “AUTO” mode
The installation is supplied by the generating sets***

End of FORCED OPERATION

- Generating set power units switched on.
- Cooling delay.
- Generating sets stopped and set to standby.

***The Kerys PLCs remain in “AUTO” mode
The installation is supplied by the grid***


Manual power plant operation

This mode of operation is selected with the “MANU” key. This enables the operator to start and stop the generating sets one by one via the MMI keypad. The generating set power unit is switched off manually with synchronisation of each generating set to the busbar using the MMI keys “+F”, “-F”, “+V” and “-V”. The distribution of power among the generating sets remains automatic. The safety devices of the generating sets remain active in this mode of operation.

This mode of operation is the responsibility of the operator.

6.3.5 Connections of the generating sets

6.3.5.1. Recommendations before the connections

| | |
|--|--|
|  Warning | Disconnect the battery cables before carrying out any work on the generating set. To disconnect the battery disconnect the negative cable (-) first. |
|--|--|

6.3.5.2. Connections according to the configurations

| | Solo generating set without inverter (A612) | Solo generating set, CRF coupling (A651) | Power plant without common part without inverter (A632) | Power plant without common part and without inverter (A633) |
|---|---|--|---|---|
| Ground connection | X | X | | |
| Ground connection box | | | X | X |
| Facility power outlet | O | O | O | O |
| Connecting cables between the generating sets (CAN BUS) | | | | X |
| Connecting cables between the generating sets (Parallel line) | | | X | |
| Power cables | X | X | X | X |
| Customer terminal: | | | | |
| Remote operation | ● | ● | ● | ● |
| External emergency stop | ● | ● | ● | ● |
| EJP | ● | ● | ● | ● |
| Switch grid detection ⁽¹⁾ | ● | | ● | ● |
| Grid detection by regulation card ⁽¹⁾ | ● | X | ● | ● |
| Emergency N/E switch control | | ● | | |
| Emergency cutout | | ● | | |
| Normal N/E switch control | | ● | | |
| Summary of faults and alarms | ● | ● | ● | ● |
| Generating set operation | ● | ● | ● | ● |
| Generating set available in Auto | ● | ● | ● | ● |

X: to be connected O: if available ●: if necessary

⁽¹⁾ Only one of the two grid detections needs to be cabled.

6.3.5.3. Earthing system (Standard only)

- The ground of the generating set must be connected to earth. To do so, use a copper cable (Green / Yellow), 25 mm² minimum for a bare cable and 16 mm² for an insulated cable, connected to the earth of the generating set, and to a ground rod of galvanised steel pushed vertically into the ground.

For a fault voltage of 25 V and a fault current of 30 mA.

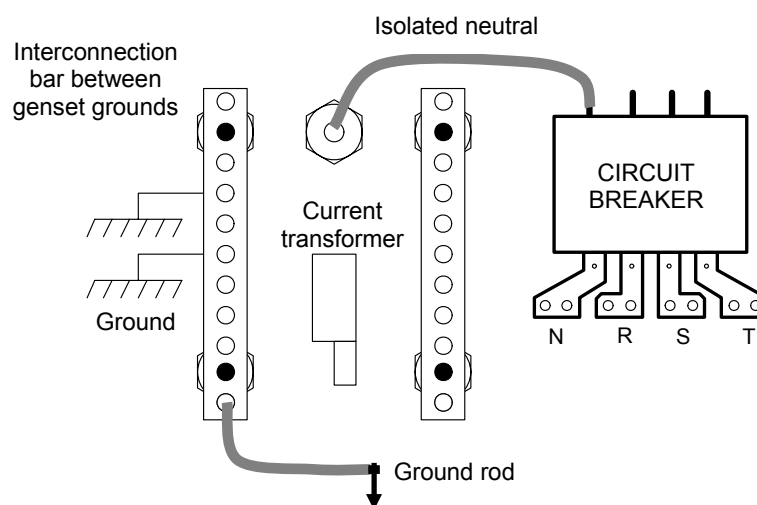
| Nature of the ground | Rod length (in metres) | |
|---|------------------------|---|
| Rich arable land, moist compact hard core | 1 | |
| Poor arable land | 1 | |
| Poor arable land, gravel, coarse hard core | 1 | |
| Stony bare soils, dry sand, impermeable rocks | 3.6 | To obtain an equivalent length several ground rods can be used connected in parallel and separated by at least their length. Example: Four 1 metre rods interconnected and separated by 1 metre respectively. |

- Check the earthing connection before switching on the generating set.
- Check that the safety earthing system is working.

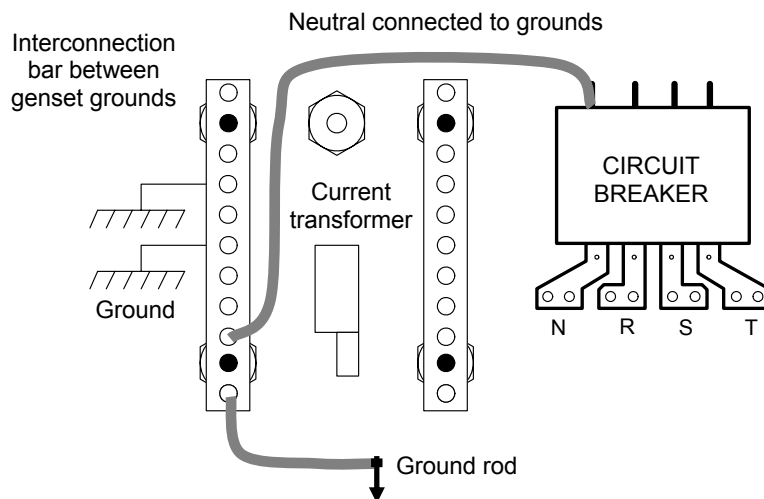
Single genset

Earthing system: IT

Active isolation controller

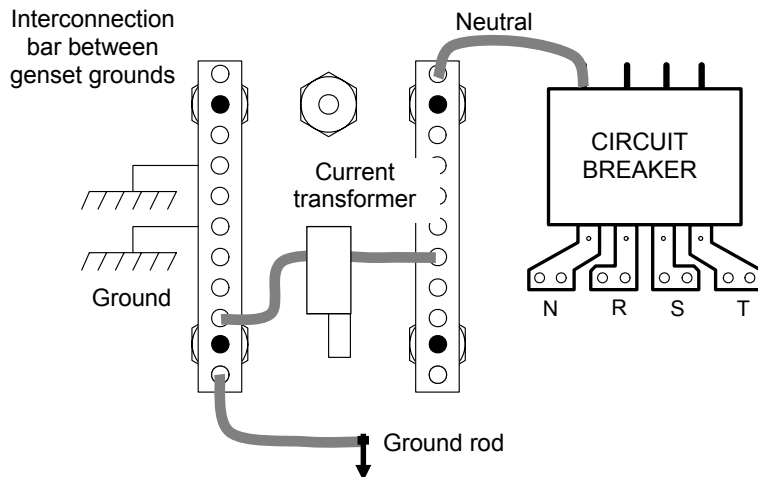


Earthing system: TNS



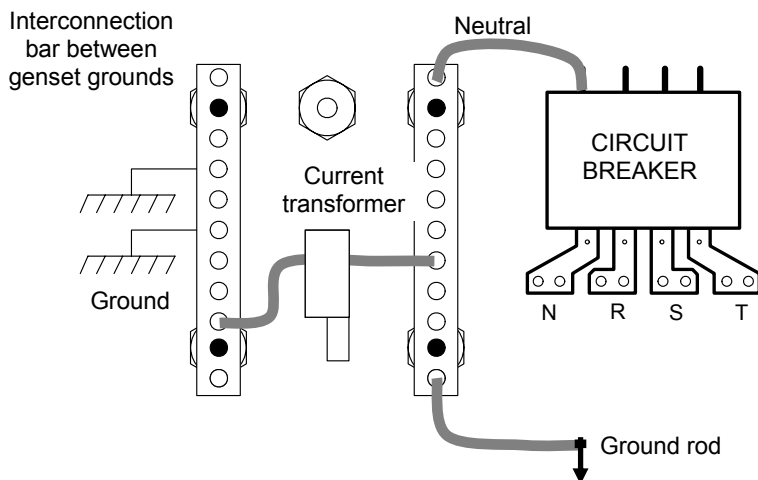
Earthing system: TT

Active differential circuit breaker

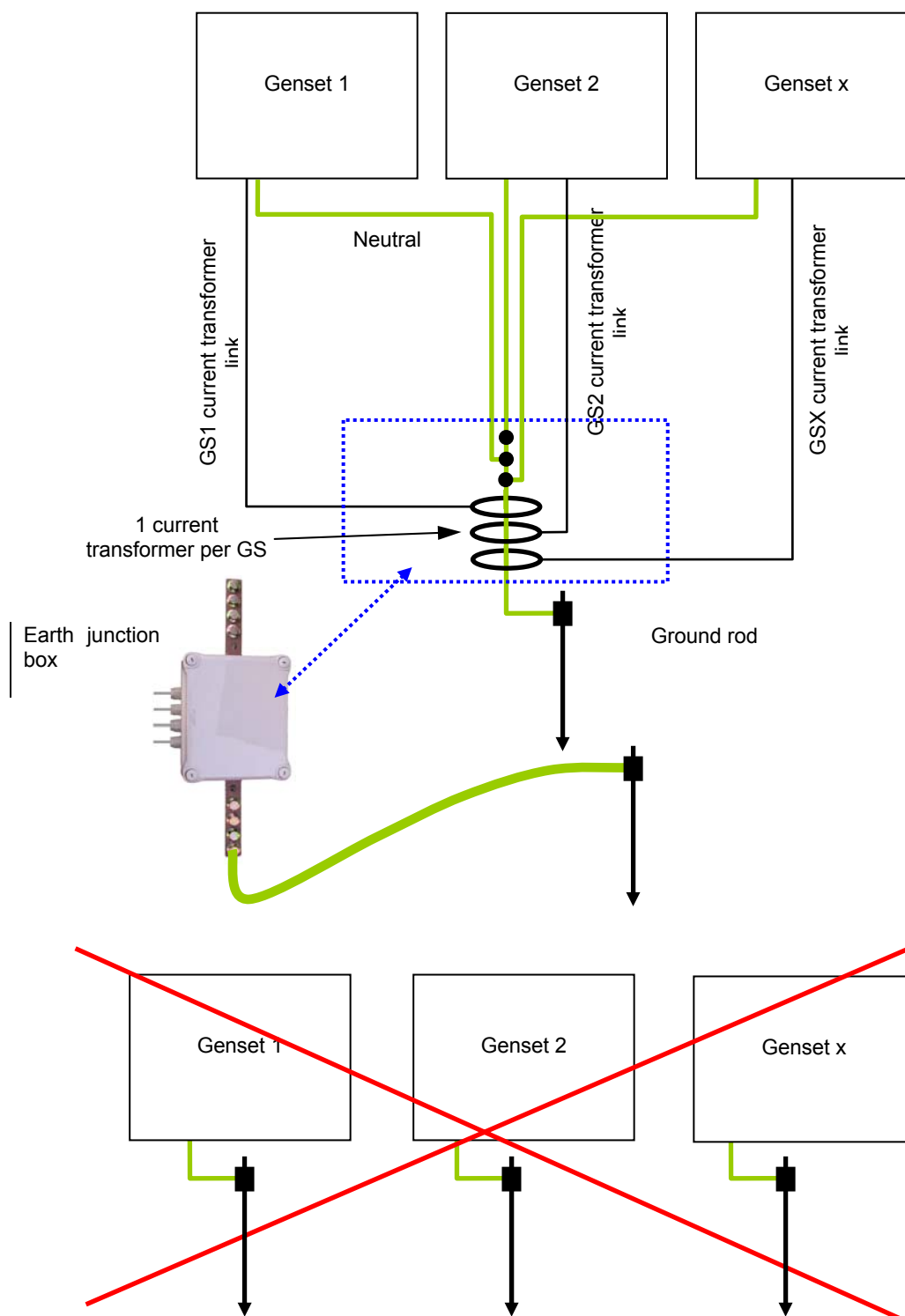


Type of earthing system: EDF application (On rental generating set only)

Active differential circuit breaker



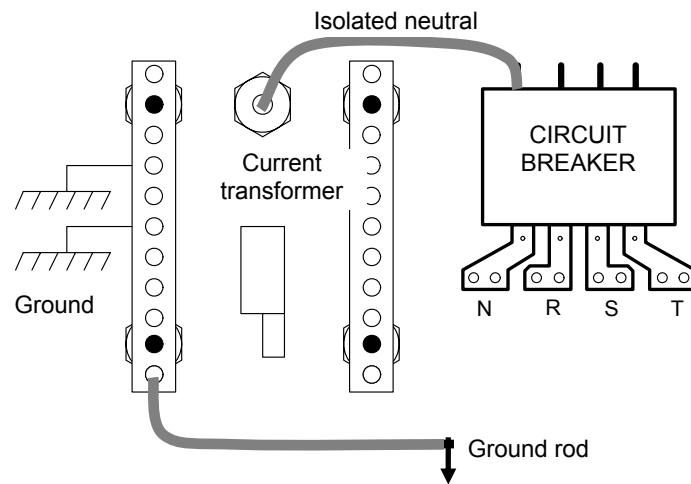
Power plant
Connection of the generating sets to the box



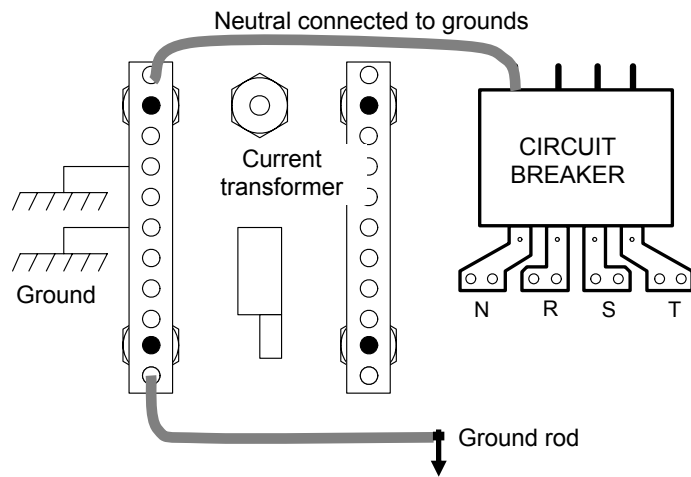
One ground rod for one generating set power plant

Important

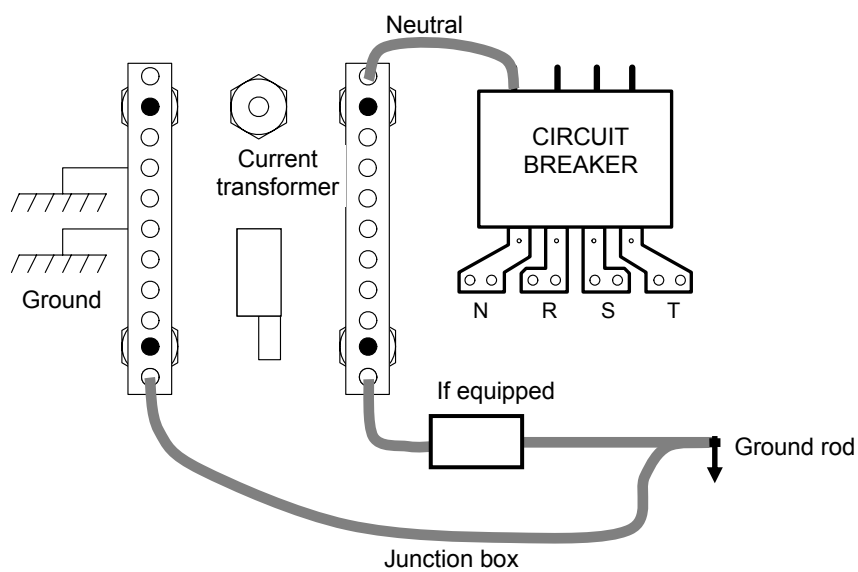
Earthing system: IT



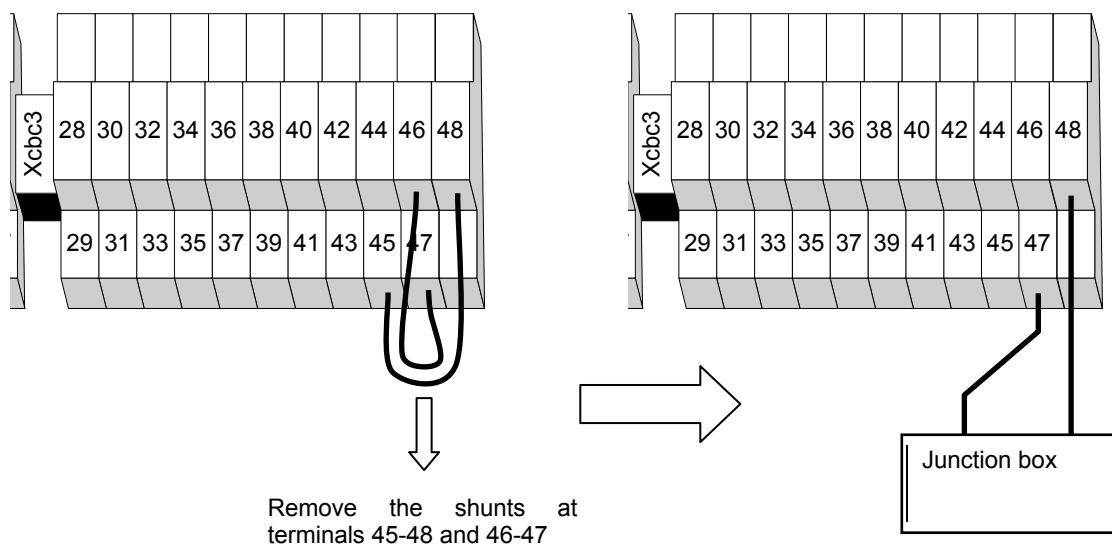
Earthing system: TNS



Earthing system: TT



Connection of generating sets to client terminal boards



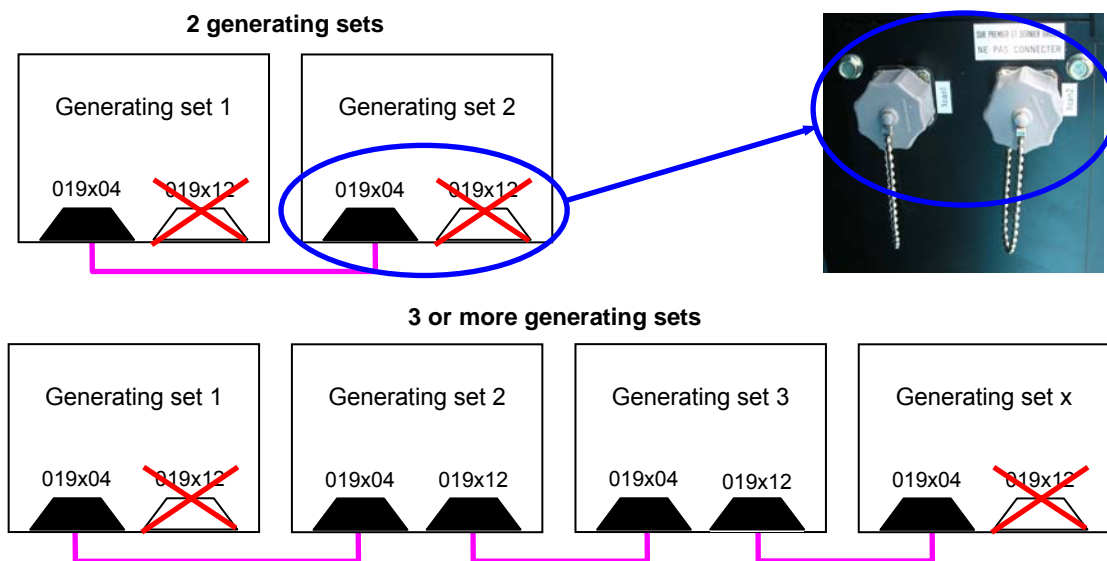
Reinsert the shunts of terminals 45 and 46 after having disconnected the current transformer from the junction box.

Important

6.3.5.4. Facility power outlet

The facility power outlet (if fitted) provides the emergency supply to the generating set from an external electrical source. It enables the different units (preheating, desk, etc.) to be powered without using their batteries.

6.3.5.5. Connecting cable between the generating sets (power plant)



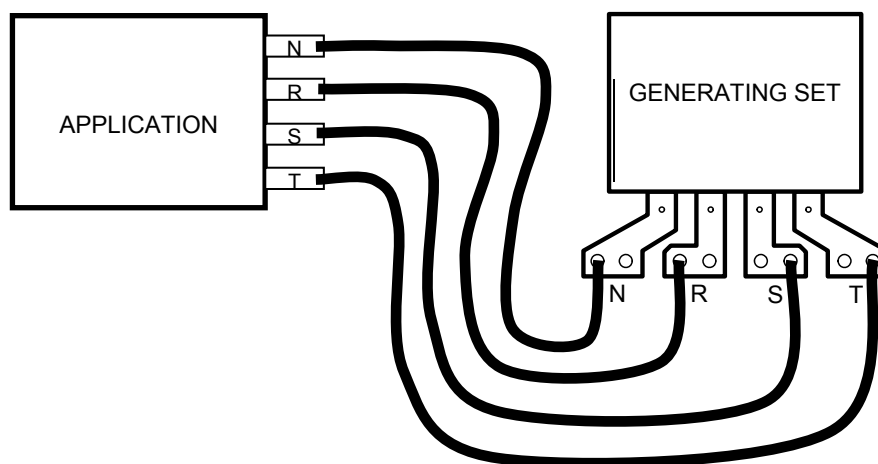
| | | |
|------------------|---|--|
| | <p>The power cables and the generating set connecting cable may intersect</p> | <p>Connecting cable</p> <p>Power cable</p> |
| <p>Important</p> | | |

| | | |
|------------------|--|--|
| | <p>Rental application</p> <p>The generating set power cables and connecting cable cannot be placed in parallel less than 1 metre apart.</p> | <p>Connecting cable</p> <p>Power cable</p> |
| <p>Important</p> | | |

| | |
|------------------|--|
| | <p>The generating set power cables, the generating set connecting cable and the connections must be in perfect condition. Replace them if necessary.</p> |
| <p>Important</p> | |

6.3.5.6. Power

1. Pass the power cables through the access hatch to the power box of the generating set (AIPR or console, depending on the generating set).
2. Connect the power cables to the busbars.
3. Connect the power cables to the application.



Important

Check that the direction of rotation of the phases between the generating set and the application is the same.

Type of cables: Use H074NF type cables according to the standards in force in the country of use of the generating set (In France refer to the standard C15.100).

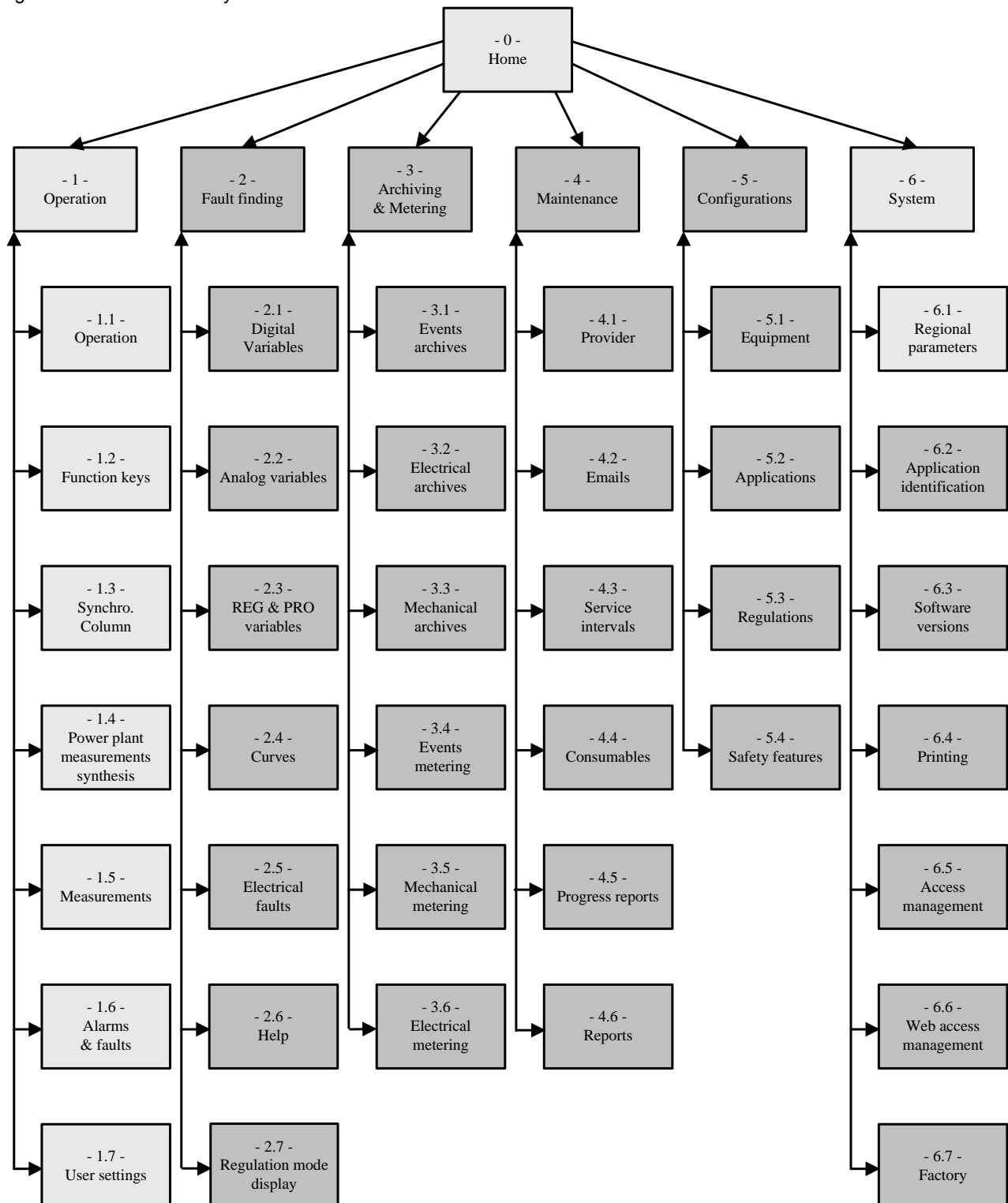
6.3.5.7. Client terminal block

Refer to the wiring diagrams according to the configuration selected and the requirements.

6.3.6 Operation and setting menus

6.3.6.1. Layout of the menus

The diagram below shows the layout of the main menus.



Important


Only the menu functions on a white background are described in this manual.

6.3.6.2. Setting of regional parameters

Without an input access code this screen allows:

- input of the display language
- setting of date and time

Navigation reference: 6.1



| | | | | | | | | | | | | | | | | | | |
|--|------------|----------------------------|---------------------|-------------------|-----------------|---|----------|---------|---------|---------|-----------|-----------------|----|----|----|----|----|----|
| 15/07/09 | 19 :10 :00 | GS 1 | Regional parameters | Stop | Faults | Alarms | | | | | | | | | | | | |
| <table border="1"> <tr> <td>Français</td> <td>English</td> <td>Espanol</td> <td>Deutsch</td> <td>Portugues</td> <td>Language option</td> </tr> </table> | | | | | | | Français | English | Espanol | Deutsch | Portugues | Language option | | | | | | |
| Français | English | Espanol | Deutsch | Portugues | Language option | | | | | | | | | | | | | |
| <table border="1"> <tr> <td>Day</td> <td>Month</td> <td>Year</td> <td>hours</td> <td>Minutes</td> <td>Seconds</td> </tr> <tr> <td>22</td> <td>10</td> <td>07</td> <td>17</td> <td>10</td> <td>00</td> </tr> </table> | | | | | | | Day | Month | Year | hours | Minutes | Seconds | 22 | 10 | 07 | 17 | 10 | 00 |
| Day | Month | Year | hours | Minutes | Seconds | | | | | | | | | | | | | |
| 22 | 10 | 07 | 17 | 10 | 00 | | | | | | | | | | | | | |
| Inhibit the keys | | | | | | | | | | | | | | | | | | |
| - 1 - Identification application | | - 2 - Software versions | | - 3 - Printing | |   | | | | | | | | | | | | |

To clean the touch screen (dust, hydrocarbons, etc.) the key inhibition function prevents keys on the screen from being pressed for some twenty seconds. A special screen shows the time elapsing.

When an access code of a sufficient level is validated this screen also allows:


- Setting of the module synchronisation time
- Selection of the logo displayed on the Kerys home screen.

When the time setting by the SNTP protocol is not active the screen looks like this.

| | | | | | | | | | | | | | | | | | | |
|--|----------------------------|-------------------|---------------------|---------------------|---|---|----------|---------|---------|---------|-----------|-----------------|----|----|----|----|----|----|
| 15/07/09 | 19 :10 :00 | GS 1 | Regional parameters | Stop | Faults | Alarms | | | | | | | | | | | | |
| <table border="1"> <tr> <td>Français</td><td>English</td><td>Espanol</td><td>Deutsch</td><td>Portugues</td><td>Language option</td></tr> </table> | | | | | | | Français | English | Espanol | Deutsch | Portugues | Language option | | | | | | |
| Français | English | Espanol | Deutsch | Portugues | Language option | | | | | | | | | | | | | |
| <table border="1"> <tr> <td>Day</td><td>Month</td><td>Year</td><td>hours</td><td>Minutes</td><td>Seconds</td></tr> <tr> <td>22</td><td>10</td><td>07</td><td>17</td><td>10</td><td>00</td></tr> </table> | | | | | | | Day | Month | Year | hours | Minutes | Seconds | 22 | 10 | 07 | 17 | 10 | 00 |
| Day | Month | Year | hours | Minutes | Seconds | | | | | | | | | | | | | |
| 22 | 10 | 07 | 17 | 10 | 00 | | | | | | | | | | | | | |
| Inhibit the keys | | SDMO welcome logo | | KOHLER welcome logo | | | | | | | | | | | | | | |
| - 1 - Identification application | - 2 - Software versions | | - 3 - Printing | |  |  | | | | | | | | | | | | |

In this case the transmission of a signal to the bus, enabling the different real time clocks to be reset, is defined by the synchronisation time.

Pressing the “KOHLER home logo” key alters the appearance of the home screen by replacing the KOHLER logo with the SDMO logo as default. The home screen then looks like this:

| | | | | | | |
|--|------------|-----------------------------|---------|------------------------|--------|--------|
| 15/07/09 | 19 :10 :00 | GS 1 | Welcome | Auto | Faults | Alarms |
|  | | | | | | |
| - 1 - Operation | | - 6 - System | | | | |
| | | - 2 - Fault finding | | - 5 - Configuration | | |
| | | - 3 - Archiving/Metering | | - 4 - Maintenance | | |

In the second case the screen has this appearance.

| | | | | | | | | | | | | | | | | | | | | | | | | |
|--|----------------------------|-------------------|---------------------|---------------------|---|---|----------|---------|---------|---------|-----------|-----------------|-----|-------|------|-------|---------|---------|----|----|----|----|----|----|
| 15/07/09 | 19 :10 :00 | GS 1 | Regional parameters | Stop | Faults | Alarms | | | | | | | | | | | | | | | | | | |
| <table border="1"> <tr> <td>Français</td><td>English</td><td>Espanol</td><td>Deutsch</td><td>Portugues</td><td>Language option</td></tr> </table> <table border="1"> <tr> <td>Day</td><td>Month</td><td>Year</td><td>hours</td><td>Minutes</td><td>Seconds</td></tr> <tr> <td>22</td><td>10</td><td>07</td><td>17</td><td>10</td><td>00</td></tr> </table> | | | | | | | Français | English | Espanol | Deutsch | Portugues | Language option | Day | Month | Year | hours | Minutes | Seconds | 22 | 10 | 07 | 17 | 10 | 00 |
| Français | English | Espanol | Deutsch | Portugues | Language option | | | | | | | | | | | | | | | | | | | |
| Day | Month | Year | hours | Minutes | Seconds | | | | | | | | | | | | | | | | | | | |
| 22 | 10 | 07 | 17 | 10 | 00 | | | | | | | | | | | | | | | | | | | |
| Inhibit the keys | | SDMO welcome logo | | KOHLER welcome logo | | | | | | | | | | | | | | | | | | | | |
| - 1 - Identification application | - 2 - Software versions | | - 3 - Printing | |  |  | | | | | | | | | | | | | | | | | | |



6.3.6.3. Information on the KERYS

Indication of the application

Navigation reference: 6.2

This screen enables SDMO to identify the project.

This information is required for queries sent to SDMO's customer service, so that the associated file can be consulted.

| | | | | | | | | | | | | | | | | | | | | | | | | |
|--|------------|-------------------|----------------------------|----------------------------|--------|---|-----------|--|--|--|--|--|-------------------|--------|--|--|--|--|-----------|--------|--|-------------------|--------|--|
| 15/07/09 | 19 :10 :00 | GS 1 | Identification application | Stop | Faults | Alarms | | | | | | | | | | | | | | | | | | |
| <table border="1"> <tr> <td>Site name</td><td colspan="5"></td></tr> <tr> <td>Dealership number</td><td colspan="2">000000</td><td colspan="3" rowspan="3"></td></tr> <tr> <td>OM number</td><td colspan="2">000000</td></tr> <tr> <td>Connection number</td><td colspan="2">000000</td></tr> </table> | | | | | | | Site name | | | | | | Dealership number | 000000 | | | | | OM number | 000000 | | Connection number | 000000 | |
| Site name | | | | | | | | | | | | | | | | | | | | | | | | |
| Dealership number | 000000 | | | | | | | | | | | | | | | | | | | | | | | |
| OM number | 000000 | | | | | | | | | | | | | | | | | | | | | | | |
| Connection number | 000000 | | | | | | | | | | | | | | | | | | | | | | | |
| - 1 - Software versions | | - 2 - Printing | | - 3 - Access management | |   | | | | | | | | | | | | | | | | | | |



Project number: reference of the production file for the control equipment.

OM number: reference of the production file for the generating set.

Connection number: reference used to identify the site at the time of the telephone connection.

Software version**Navigation reference:** 6.3

The information relating to the software versions installed in the different modules is accessible from this menu. Only the lines corresponding to the installed equipment appear

| | | | | | | |
|-------------------------------------|----------------|-------------------|------------------------|----------------------------|--------|---|
| 15/07/09 | 19 :10 :00 | GS 1 | Software versions | Stop | Faults | Alarms |
| | Module | Software versions | Software version dates | | | |
| | IHM | 0.00 | 00/00/00 | | | |
| | Base | 0.00 | 00/00/00 | | | |
| | Resident logic | 0.00 | 00/00/00 | | | |
| | Regulation | 0.00 | | | | |
| | Protection | 0.00 | | | | |
| | Engine | 0.00 | | | | |
| - 1 - Identification application | | - 2 - Printing | | - 3 - Access management | |   |

6.3.6.4. Operating menus

Operation

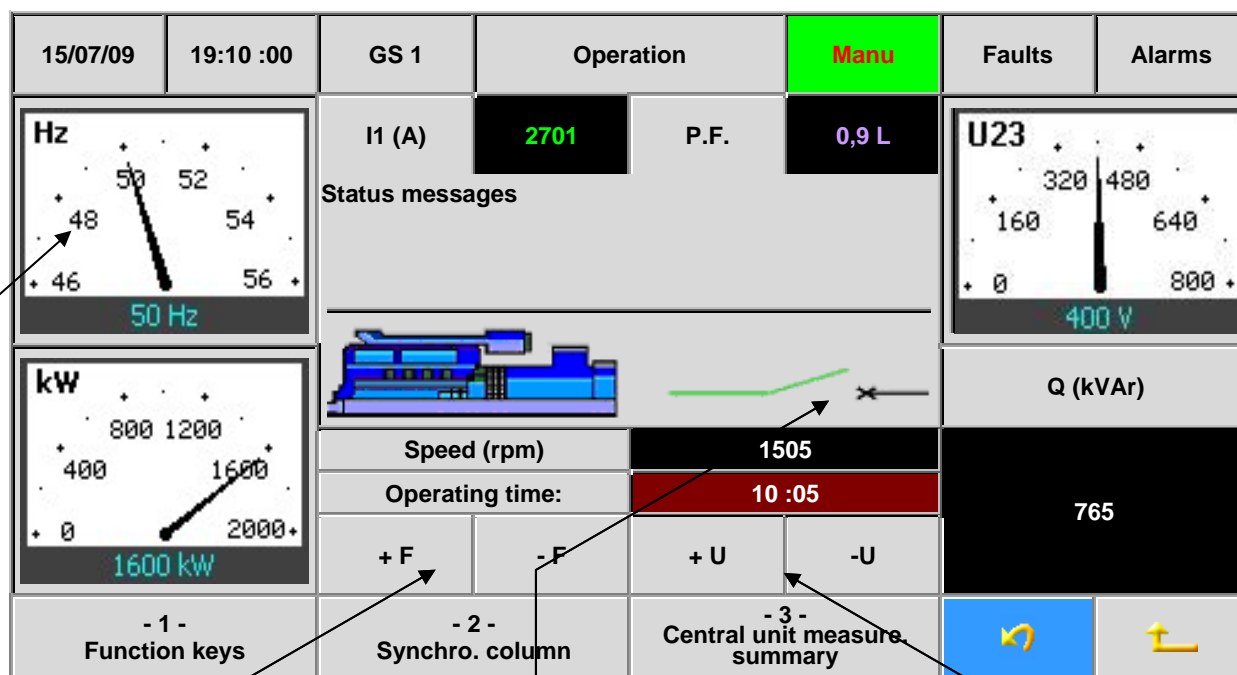
This main screen displays all the main electrical parameters of the generating set.

It is the general operating and monitoring screen for the generating set.

This screen can also be displayed by pressing the indicator displaying the operation mode of the generating set.

The frequency, U23 voltage, active and reactive power indicators, can be displayed in analog or digital form. Switching from one mode to another is performed by pressing the desired indicator.

Navigation reference: 1.1



Control of speed of rotation of the engine

Control of alternator voltage

Indication of the genset output position

The dial is automatically scaled beyond 46Hz

In the needle dials the nominal values are in blue



Important

The speed and voltage adjustment keys are only displayed for coupled applications in manual mode.

Alarms and faults

This menu can also be called directly by pressing the flashing “Alarms” and “Faults” keys on the upper band.

This screen allows the user to view the list of faults present on the installation.

The first two columns give details of the date and time that the fault appeared.

The “Status” column indicates whether the fault is still present “1”, or not present “0”.

The “@” column gives the address of the variable associated with the fault.

The “Text” column identifies the type of fault.

A line with a red background characterises a fault and a line with an orange background characterises an alarm.

Navigation reference: 1.6

| 15/07/09 | 19 :10 :00 | GS 1 | Alarms & Faults | Stop | Faults | Alarms |
|----------------------|-------------|------------------------|-----------------|--|--------|--------|
| Date | Time | Status | @ | Title | | |
| 26/11/03 | 11:11:12'55 | 1 | 6131 | HT LOW COOLANT LEVEL FAULT | | |
| 26/11/03 | 10:35:16'28 | 0 | 6017 | INSULATION 1 ALARM | | |
| 26/11/03 | 10:10:10'10 | 0 | 60C3 | CIRCUIT BREAKER FAULT ON GENERATING SET OUTPUT | | |
| | | | | | | |
| | | | | | ▲ | ▼ |
| -1- Function keys | | -2- Synchro. column | | -3- Central unit measure. summary | ↶ | ↷ |

Active line

Keys for scrolling when the list is longer than the number of lines possible on the screen, i.e. 4 lines

To clear a fault, it is necessary to:

- check that the fault has disappeared (status **0**) and whether it is necessary to eliminate its causes
- select the line in question; the text on the line is displayed in white
- press the **"Reset"** key on the keypad; the line is deleted.



Important

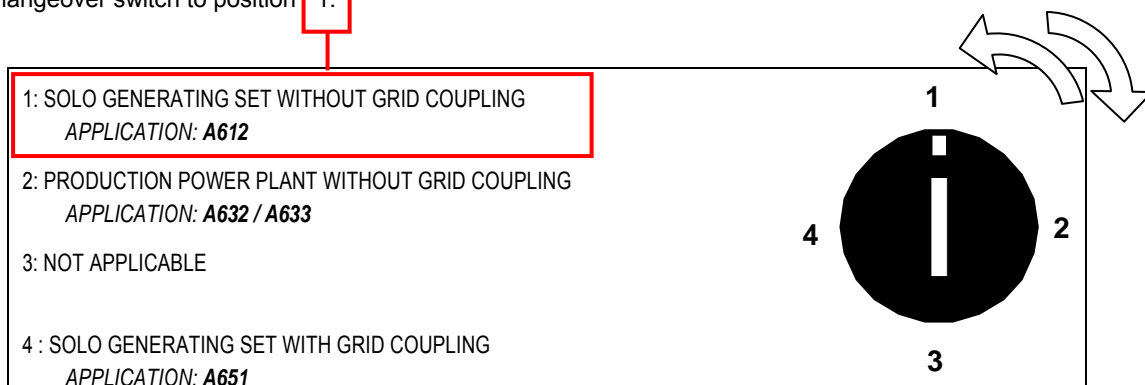
When a fault is displayed, its effect on the operation remains active even if its cause has disappeared. When in Manu or Auto mode, if the user wants to clear a fault with a "stopped" clearance mode, a screen will inform the user to switch to stop mode.

6.3.7 Rental configurations

6.3.7.1. Choice of application configuration

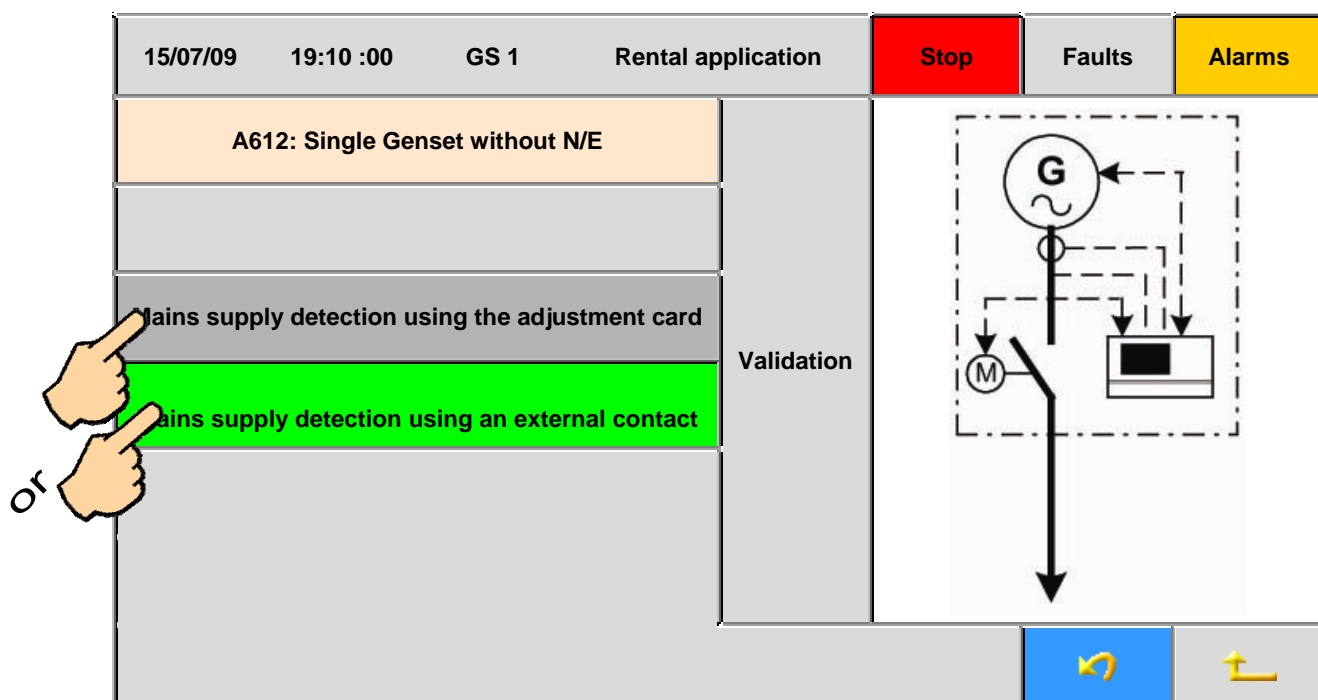
Solo generating set Without inverter (A612)

1. Turn off the battery isolator switch.
2. Check that the emergency stop buttons are activated.
3. Press the "STOP" button on the KERYS.
4. Turn the changeover switch to position **1.**




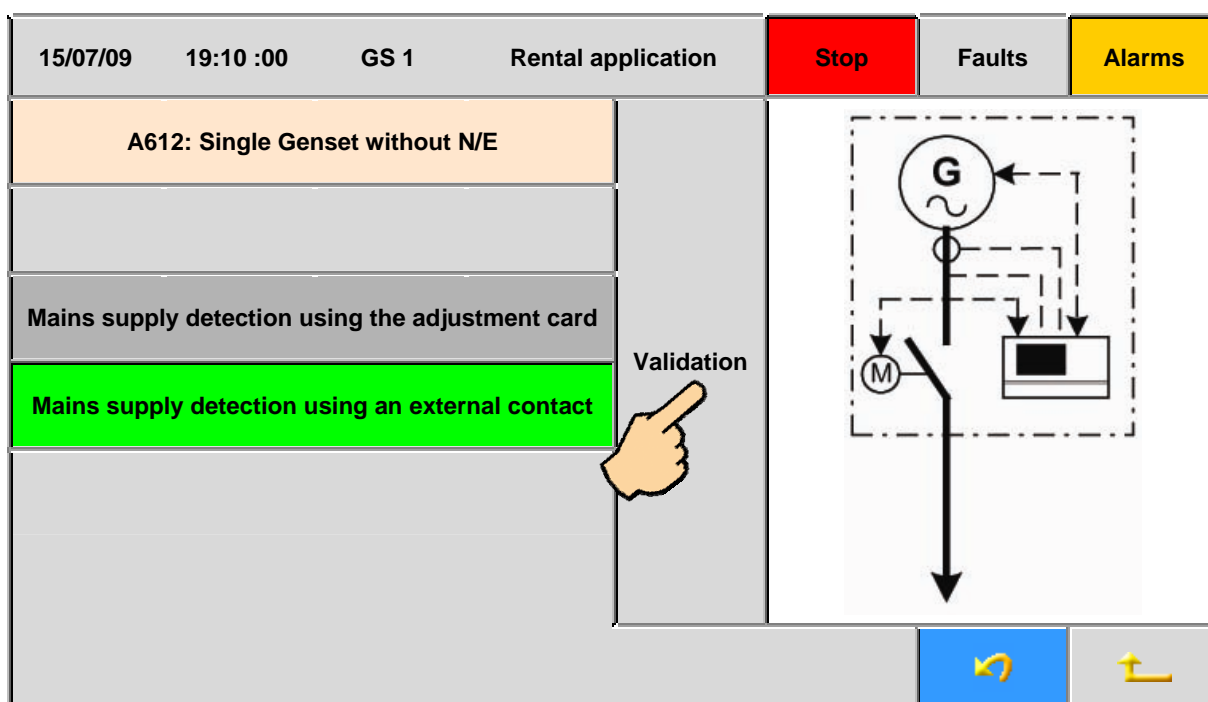
(If the switch is already set to "1", turn the switch and return to position "1")

After changeover, the screen below appears.

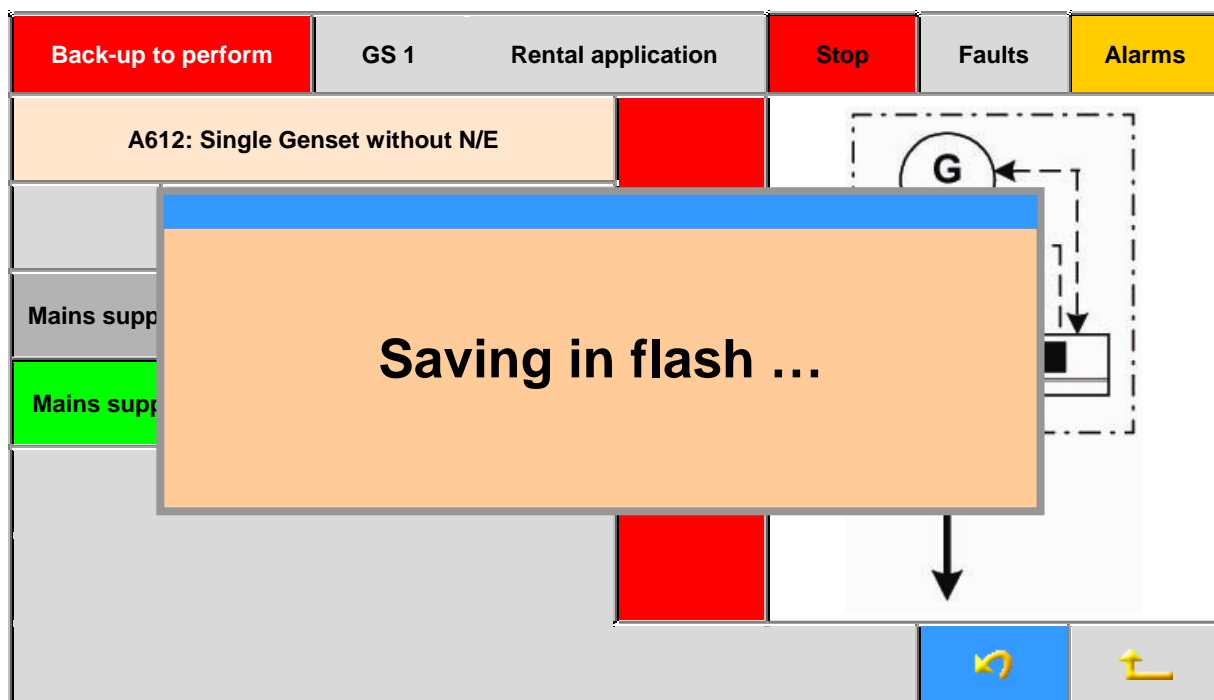


5. Select the configuration of the mains detection of the generating set by clicking directly on the touch screen.
 - ✓ For a **mains detection by means of the regulation card** you must select the configuration “**Mains supply detection using the adjustment card**” and connect the voltage reference to the terminals **Xcbc1 - 1-2-3**.
 - ✓ For **mains detection by an external switch** you must select the configuration “**Mains supply detection using an external contact**” and connect the external switch to the terminals **Xcbc3 - 34-35**.
 - ✓ For **starting by means of an external switch** you must select the configuration “**Mains supply detection using an external contact**” and connect the external switch to the terminals **Xcbc3 - 32-33**.
 - ✓ For **solo starting**, in the absence of a mains connection, you must select the configuration “**Mains supply detection using an external contact**”. **No connection** is necessary.

| | |
|---|--|
|  | <p>N.B. selecting detection depends on the connection made according to Section “Connections of the generating sets”.</p> |
| <p>Important</p> | |



6. Press “Validation” on the touch screen.



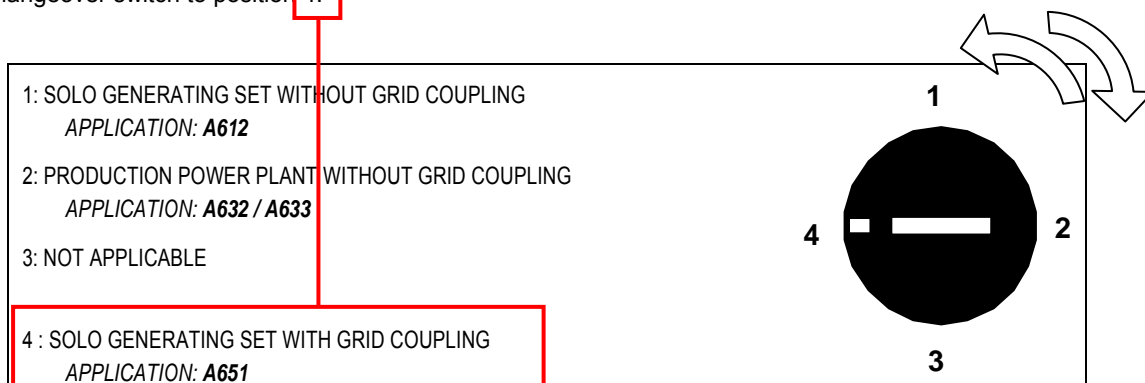
7. The KERYs saves your new configuration.

8. After return to the KERYs home screen,

| | |
|-----------|--|
| | <p>The configuration will only be taken into account if the following operations are carried out:</p> <ul style="list-style-type: none"> ✓ Turn on the battery isolator switch. ✓ Wait 5 seconds. ✓ Turn off the battery isolator switch. |
| Important | |

Solo generating set, CRF coupling (A651)

1. Turn off the battery isolator switch.
2. Check that the emergency stop buttons are activated.
3. Press the “STOP” button of the KERYs.
4. Turn the changeover switch to position 4.



(If the switch is already set to “4”, turn the switch and return to position “4”)

After changeover, the screen below appears.

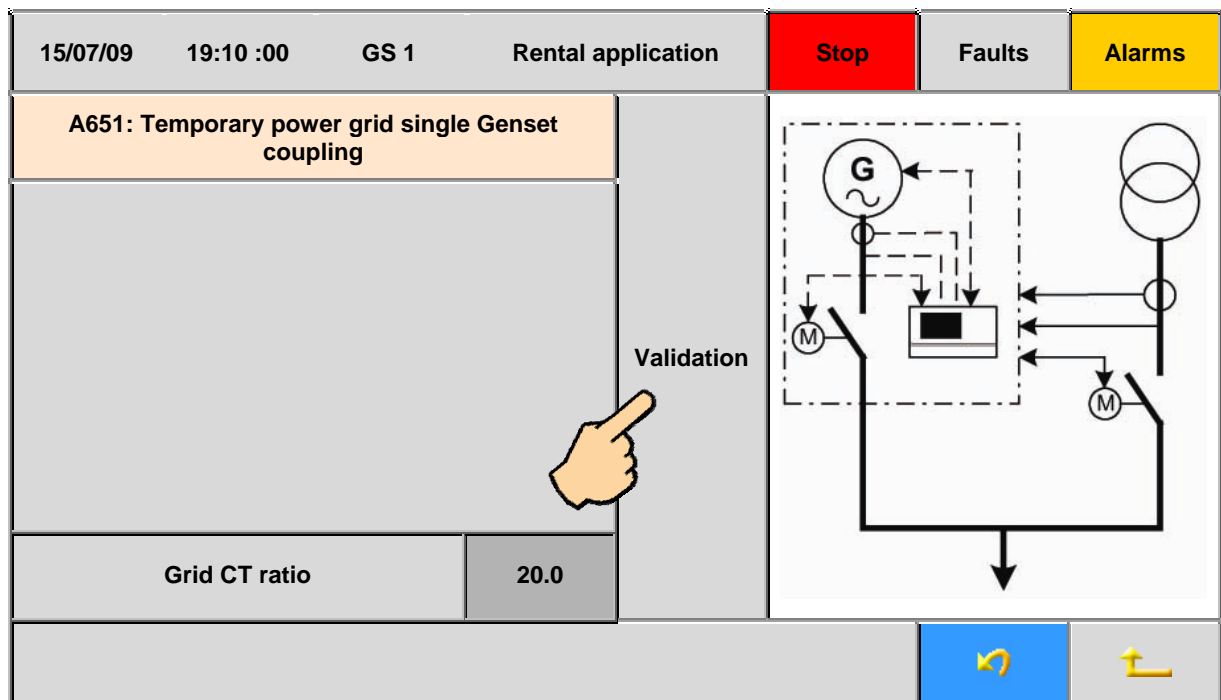
| | | | | | | |
|---|-----------|------|--------------------|------|--------|--------|
| 15/07/09 | 19:10 :00 | GS 1 | Rental application | Stop | Faults | Alarms |
| A651: Temporary power grid single Genset coupling | | | | | | |
| Validation | | | | | | |
| | | | | | | |
| Grid CT ratio | | 20.0 | | | | |

5. To enter the value of the grid current transformer ratio: press the “GRID CT RATIO” button on the touch screen.
 - ✓ Using the alphanumeric keys of the MICS KERYS: enter the value of the CT ratio in tenths.
Example: CT = 100A/5A (calculation: $100/5 = 20$; $20 \times 10 = 200$) value to be entered **200**.

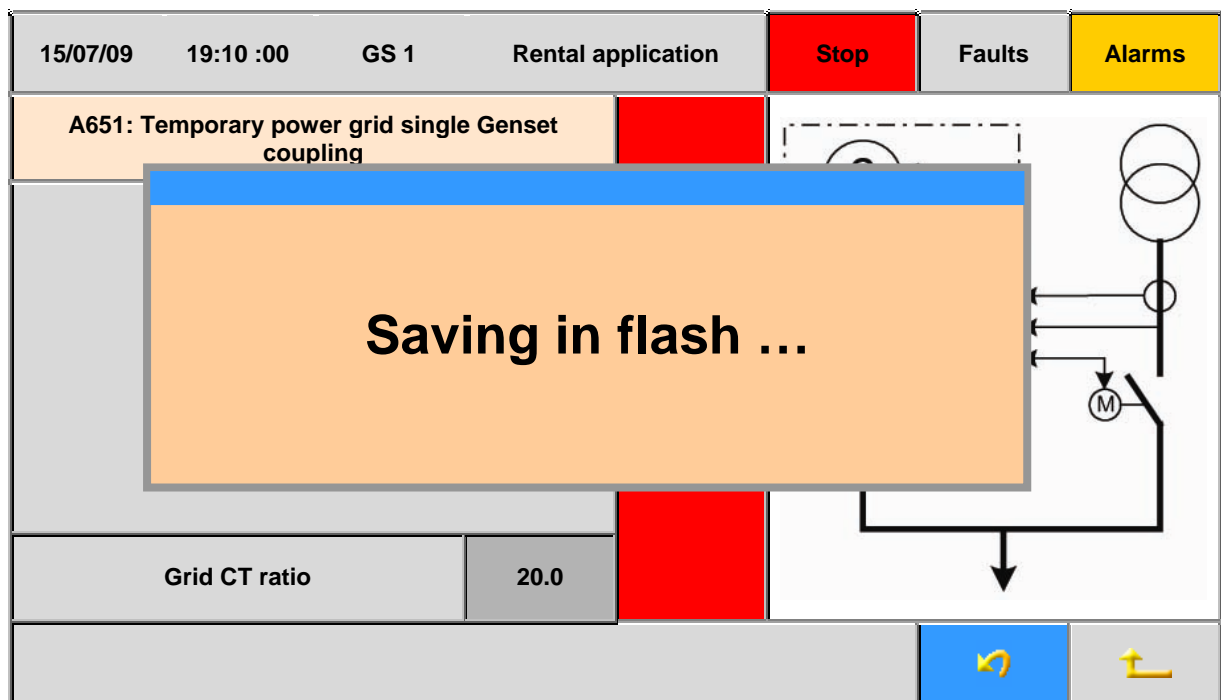


| | | |
|---------------------------------|------|---------|
| CT BUSBAR/Grid setting 1 (1/10) | | |
| 0<= | 0200 | <=32767 |
| Valid | | Esc. |

6. Then press “VALID” .




7. Press the "Validation" button on the touch screen.



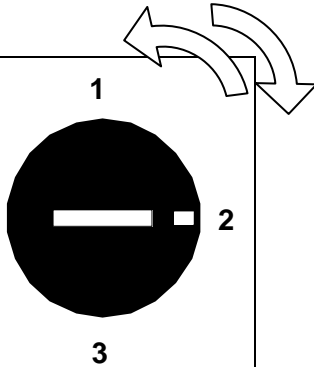
8. The KERY5 saves your new configuration.

9. After return to the KERYS home screen,

| | |
|---|---|
|  | <p>The configuration will only be taken into account if the following operations are carried out:</p> <ul style="list-style-type: none"> ✓ Turn on the battery isolator switch. ✓ Wait 5 seconds. ✓ Turn off the battery isolator switch. |
| <p>Important</p> | |

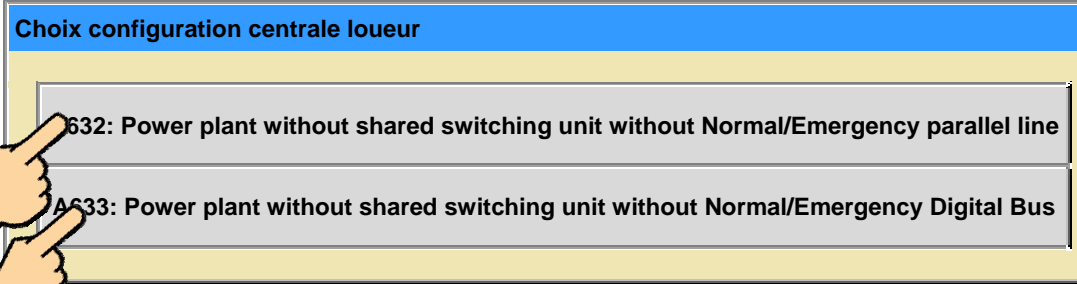
Power plant Without common part and without inverter (A632-A633)

1. Turn off the battery isolator switch.
2. Check that the emergency stop buttons are activated.
3. Press the “STOP” button on the KERYS.
4. Turn the changeover switch to position 2.

| | |
|--|--|
| <p>1: SOLO GENERATING SET WITHOUT GRID COUPLING APPLICATION: A612</p> <p>2: PRODUCTION POWER PLANT WITHOUT GRID COUPLING APPLICATION: A632 / A633</p> <p>3: NOT APPLICABLE</p> <p>4: SOLO GENERATING SET WITH GRID COUPLING APPLICATION: A651</p> |  |
|--|--|

(If the switch is already set to “2”, turn the switch and return to position “2”)

After changeover, the screen below appears.




Choix configuration centrale loueur

A632: Power plant without shared switching unit without Normal/Emergency parallel line

A633: Power plant without shared switching unit without Normal/Emergency Digital Bus

5. Select the configuration “**A632: Power plant without shared switching unit without Normal/Emergency parallel line**” by directly clicking on the touch screen.
Select the configuration “**A633: Power plant without shared switching unit without Normal/Emergency Digital Bus**” by clicking directly on the touch screen.

| | |
|---|---|
|  | <p>N.B. selecting detection depends on the connection made according to Section 5. “Connections of the generating sets”.</p> |
| <p>Important</p> | |

| Back-up to perform | GS 1 | Rental application | Stop | Faults | Alarms |
|--|------|--------------------|------|--------|--------|
| A633: Power plant without shared switching unit without Normal/Emergency Digital Bus | | | | | |
| Number of gen sets in power plant | | 2 | | | |
| Genset number | | 1 | | | |
| Validation | | | | | |

6. Press the generating set number on the touch screen.

| Back-up to perform | GS 1 | Rental application | Stop | Faults | Alarms |
|--|------|--|------|--------|--------|
| A633: Power plant without shared switching unit without Normal/Emergency Digital Bus | | | | | |
| Number of gen sets in power plant | | 2 | | | |
| Genset number | | <div> <div>Number of gen sets in power plant</div> <div>0<= 02 <=15</div> <div>Valid Esc.</div> </div> | | | |
| | | | | | |

7. Enter the number of generating sets in the power plant using the numeric keypad. Start with "0" if the number is less than 10 generating sets.
E.g.: 2 generating sets ⇒ enter 0 then 2; 10 generating sets ⇒ enter 1 then 0.
8. Press "Valid" to confirm the entry.

| | | | | | | |
|--|------|--------------------|------|--------|--------|--|
| Back-up to perform | GS 1 | Rental application | Stop | Faults | Alarms | |
| A633: Power plant without shared switching unit without Normal/Emergency Digital Bus | | | | | | |
| Number of gen sets in power plant | 2 | Validation | | | | |
| Genset number | 1 | | | | | |
| | | | | | | |
| | | | | | | |

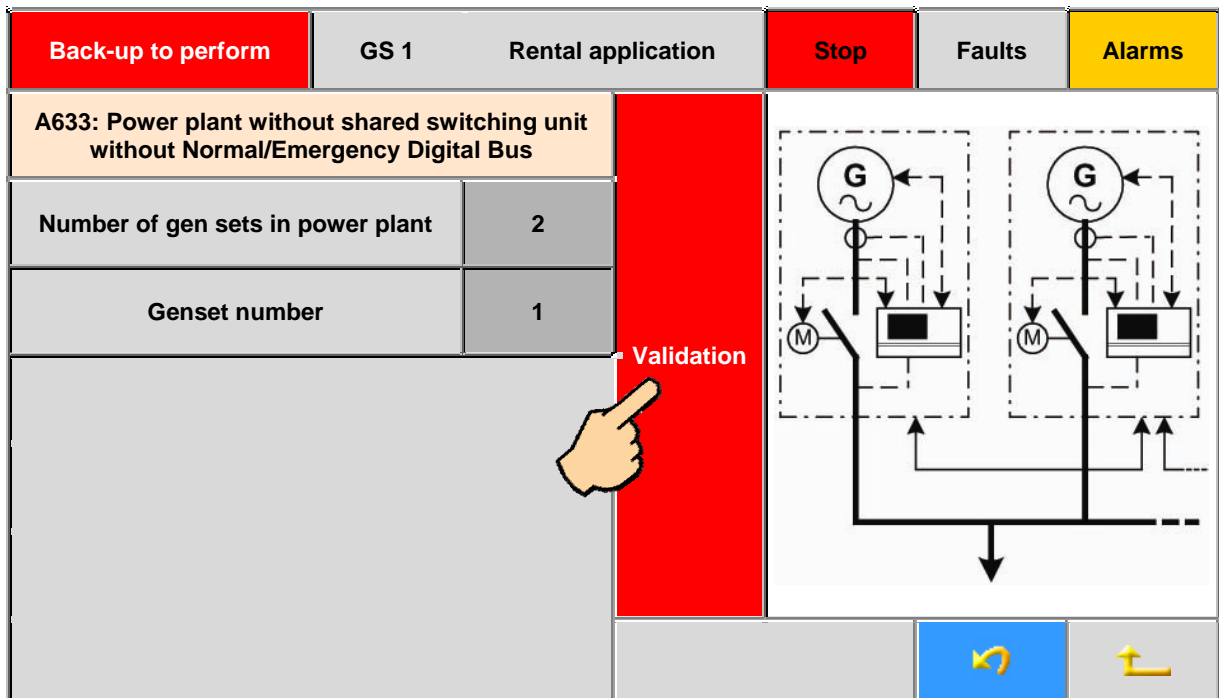
9. Press the generating set number on the touch screen.

| | | | | | | |
|--------------------------------|--------|--------------------|------|--------|--------|--|
| Back-up to perform | GS 1 | Rental application | Stop | Faults | Alarms | |
| A633: Power plant without Norm | | | | | | |
| Base identification | | | | | | |
| Number of gen se | 1 2 | | | | | |
| Genset r | Valid | Esc. | | | | |
| | | | | | | |

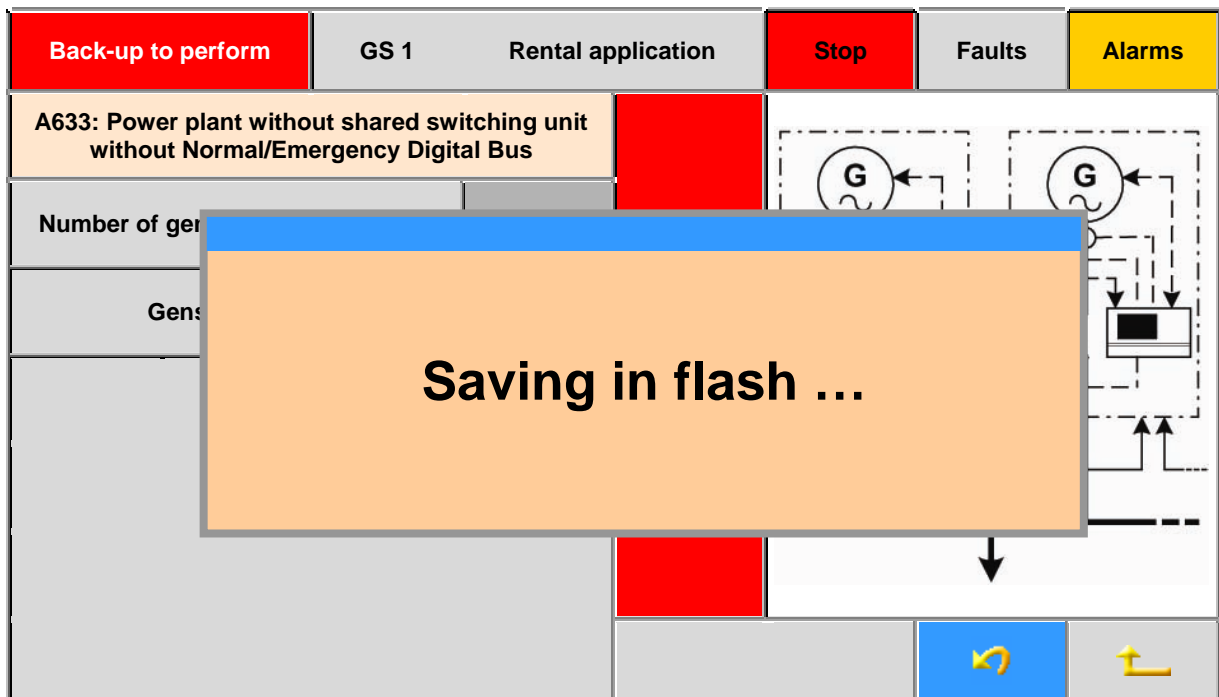
10. Select the number of the generating set with the arrows.

| | |
|-----------|---|
| | <p>The number of the generating set determines its type of connection, see the section “Electrical connections”</p> |
| Important | |

11. Press “Valid” to confirm the entry.





12. Press "Validation" on the touch screen.



13. The Kerys saves your new configuration.

14. After returning to the Kerys home screen,

| | |
|---|--|
|  | <p>The configuration will only be taken into account if the following operations are carried out:</p> <ul style="list-style-type: none"> ✓ Turn on the battery isolator switch. ✓ Wait 5 seconds. ✓ Turn off the battery isolator switch. |
| Important | |



| | |
|---|--|
|  | <p>Operations to be carried out on each generating set of the power plant.</p> |
| Important | |

6.3.8 Use

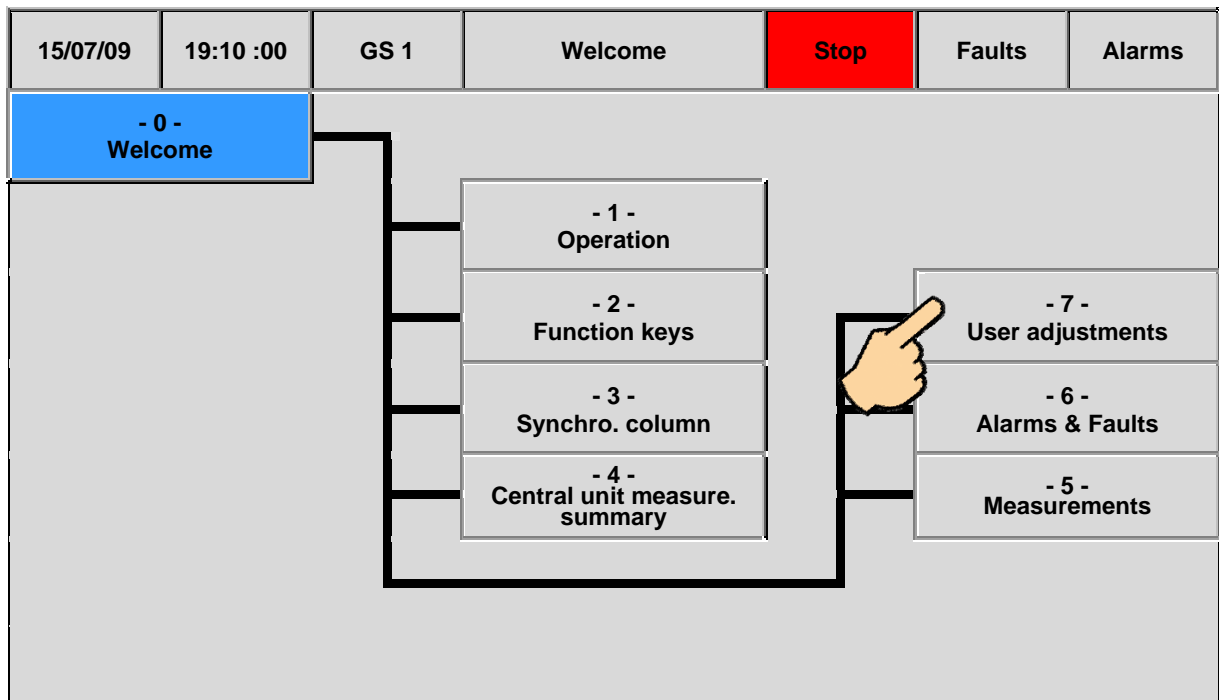
6.3.8.1. Choice of priority generating set in power plant (if equipped)

Mnemonic aid info for menus:

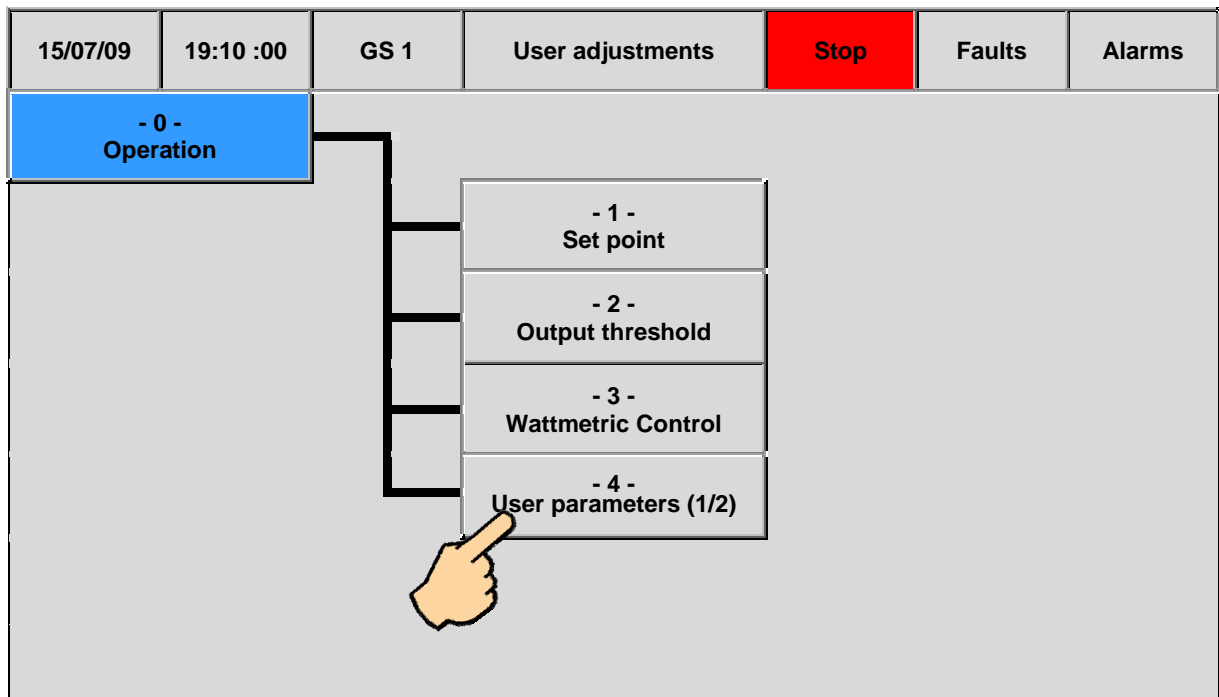
“1” – “7” – “4” – “3” – “GS selection” “Priority selection” “Valid”

| | | | | | | |
|--|-----------|-------------------------------|---------|------------------------|-----------------|--------|
| 15/07/09 | 19:10 :00 | GS 1 | Welcome | Stop | Faults | Alarms |
| <div>  Global Power Solution™</div> | | | | | | |
| - 1 - Operation | | | | | - 6 - System | |
| | | - 2 - Fault finding | | | | |
| | | - 3 - Archiving & Metering | | - 5 - Configuration | | |
| | | | | - 4 - Maintenance | | |

1. Press “Operation” on the touch screen.




2. Press "User settings" on the touch screen.



3. Press "User parameters (1/2)" on the touch screen.

| | | | | | | |
|---|-----------|------------------------|---------------------------------|------|--------|--------|
| 15/07/09 | 19:10 :00 | GS 1 | User parameters (1/2) | Stop | Faults | Alarms |
| Power return Confirmation request | | Without ▼ | No load test time delay (sec) : | 600 | | |
| | | Power 1 | | | | |
| Power loss time delay (sec) : | | 3 | | | | |
| Power return time delay (sec) : | | 180 | | | | |
| Inversion in non-coupl. In emergency mode | | Whithout ▼ | | | | |
| Inversion in non-coupl. In normal mode | | Whithout ▼ | | | | |
| -1- Set point | | -2- Wattmetric COntrol | -3- Generating set priority | | | |



4. Press "Generating set priority" on the touch screen.

| | | | | | | |
|------------------------|-----------|----------------|-----------------------------------|-----------------|--------|--------|
| 15/07/09 | 19:10 :00 | GS 1 | Generating set priority | Stop | Faults | Alarms |
| Modification | | | | | | |
| GS select. | | 01 | ▼ | Priority select | ▲ | 02 |
| | | Valid | Return to the previous priorities | | | |
| Display | | | | | | |
| GS | 1 | 2 | | | | |
| PRI | 02 | 01 | | | | |
| -1- General parameters | | -2- Thresholds | | | | |

5. Press the selection arrows on the touch screen to select the generating set.

| | | | | | | |
|---------------------------|-----------|-------------------|--------------------------------------|--------------------|--------|--------|
| 15/07/09 | 19:10 :00 | GS 1 | Generating set priority | Stop | Faults | Alarms |
| Modification | | | | | | |
| GS select. | | 01 | | Priority select | | 02 |
| | | Valid | Return to the previous priorities | | | |
| Display | | | | | | |
| GS | 1 | 2 | | | | |
| PRI | 02 | 01 | | | | |
| -1- General parameters | | -2- Thresholds | | | | |

6. Press the selection arrows on the touch screen to select the priority of the generating set selected.

| | | | | | | |
|---------------------------|-----------|-------------------|--------------------------------------|--------------------|--------|--------|
| 15/07/09 | 19:10 :00 | GS 1 | Generating set priority | Stop | Faults | Alarms |
| Modification | | | | | | |
| GS select. | | 01 | | Priority select | | 02 |
| | | Valid | Return to the previous priorities | | | |
| Display | | | | | | |
| GS | 1 | 2 | | | | |
| PRI | 02 | 01 | | | | |
| -1- General parameters | | -2- Thresholds | | | | |

7. Press "Valid" on the touch screen.

| | | | | | | | | |
|---------------------------|----|-------------------|-------------------------|-----------------------------------|-------------|----|--------|--------|
| Back-up to perform | | GS 1 | Generating set priority | | Stop | | Faults | Alarms |
| Modification | | | | | | | | |
| GS select. | ▲ | 01 | ▼ | Priority select | ▲ | 02 | ▼ | |
| | | Valid | | Return to the previous priorities | | | | |
| Display | | | | | | | | |
| GS | 1 | 2 | | | | | | |
| PRI | 02 | 01 | | | | | | |
| -1- General parameters | | -2- Thresholds | | | | ↶ | | ↷ |

8. Press "Save" on the touch screen.

| | | | | | | | | |
|---------------------------|----|-------------------|-------------------------|-----------------|-------------|----|--------|--------|
| Back-up to perform | | GS 1 | Generating set priority | | Stop | | Faults | Alarms |
| Modification | | | | | | | | |
| GS select. | ▲ | 01 | ▼ | Priority select | ▲ | 02 | ▼ | |
| | | Valid | | Esc. | | | | |
| | | Save in flash | | | | | | |
| GS | 1 | 2 | | | | | | |
| PRI | 02 | 01 | | | | | | |
| -1- General parameters | | -2- Thresholds | | | | ↶ | | ↷ |


9. Press "Valid" on the touch screen.

| | | | | | | | | | | | | | | | |
|------------------------|--|---------------------|--|-------------------------|--|------|--|--------|--|--------|--|---|--|---|--|
| Back-up to perform | | GS 1 | | Generating set priority | | Stop | | Faults | | Alarms | | | | | |
| Modification | | | | | | | | | | | | | | | |
| GS sel | | Saving in flash ... | | | | | | | | 2 | | ▼ | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| GS | | | | | | | | | | | | | | | |
| PRI | | 02 | | 01 | | | | | | | | | | | |
| -1- General parameters | | | | -2- Thresholds | | | | | | | | ↶ | | ↷ | |

10. The Kerys saves your new configuration.

| | | | | | | | | | | | | | | | |
|------------------------|--|-----------|--|----------------|--|-------------------------|--|-----------------------------------|--|--------|--|--------|--|---|--|
| 15/07/09 | | 19:10 :00 | | GS 1 | | Generating set priority | | Stop | | Faults | | Alarms | | | |
| Modification | | | | | | | | | | | | | | | |
| GS select. | | ▲ | | 01 | | ▼ | | Priority select | | ▲ | | 02 | | | |
| | | | | Valid | | | | Return to the previous priorities | | | | | | | |
| Display | | | | | | | | | | | | | | | |
| GS | | 1 | | 2 | | | | | | | | | | | |
| PRI | | 02 | | 01 | | | | | | | | | | | |
| -1- General parameters | | | | -2- Thresholds | | | | | | | | ↶ | | ↷ | |

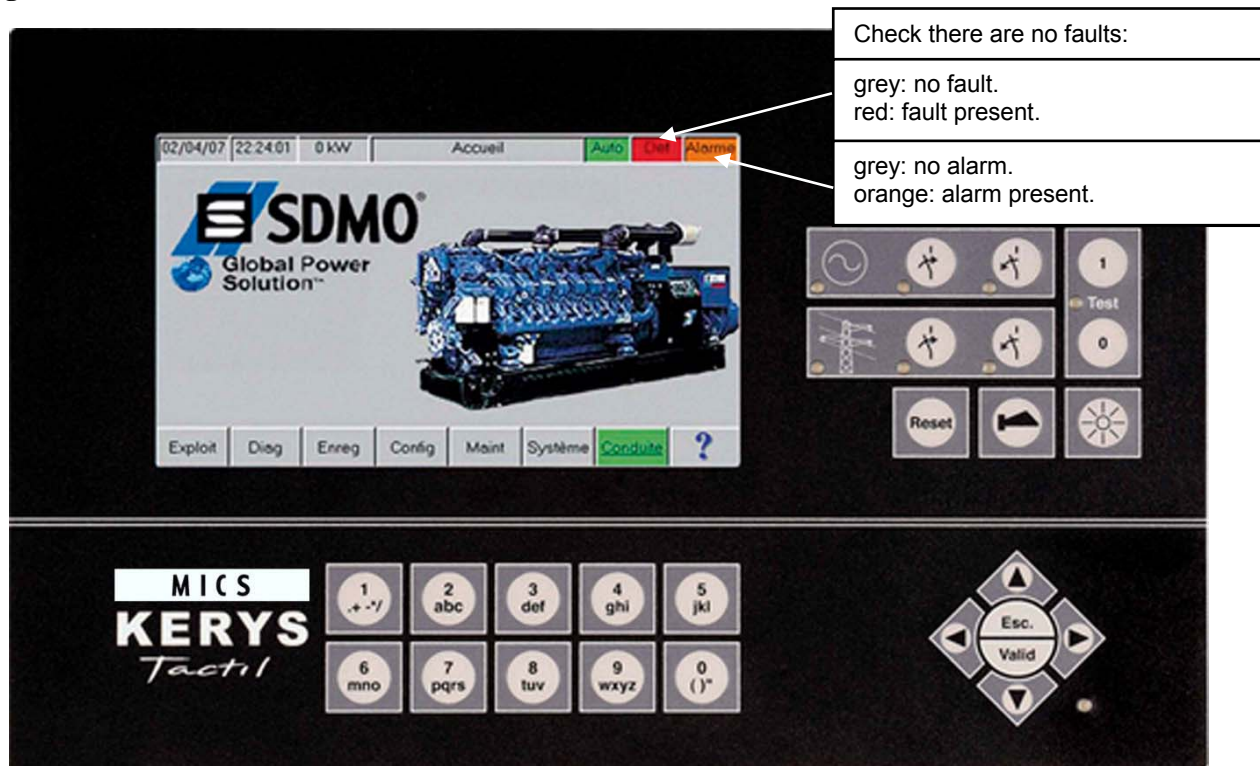
11. Press "Generating set priority" on the touch screen to return to the home screen.

| | |
|---|--|
|  | <p>The configuration will only be considered valid if the following operations are carried out:</p> <ul style="list-style-type: none"> ✓ Open the battery cutout. ✓ Wait 5 seconds. ✓ Close the battery cutout. |
| | <p>Important</p> |

6.3.8.2. Starting, tests and stop

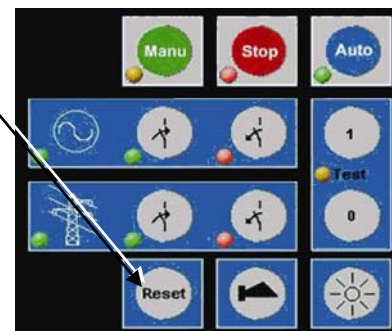
In manual mode

Starting

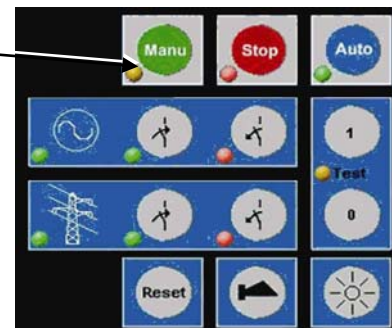


If faults are present, the fault management screen can be accessed by pressing **Reset**.

Refer to the section "Alarms and Faults" in the "Operating menus" to eliminate the faults.

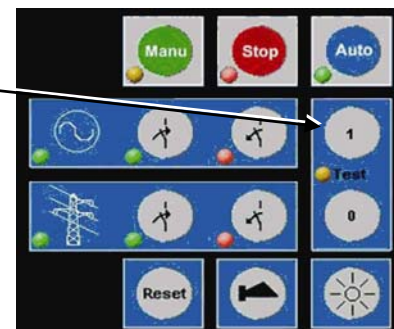


If no faults are present, manual mode can be activated by pressing **Manu**.

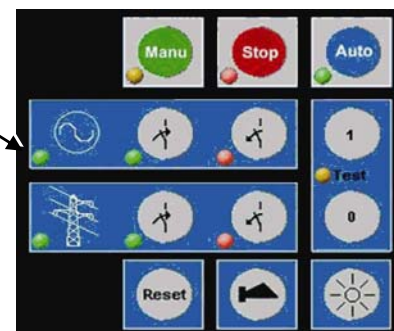


The manual start-up phase will begin once **key 1** in the test keypad is pressed.

The start-up request is maintained until the generating set starts (it is not necessary to keep key 1 pressed).
This method may not, under any circumstances, be used to turn the engine over manually.

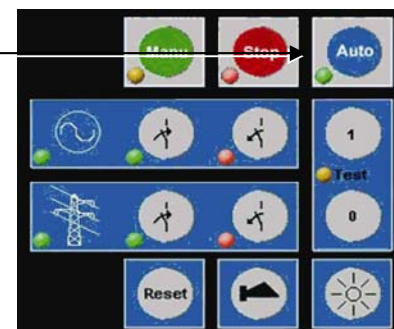


During the start-up phase and until the alternator voltage and speed of the generating set stabilise, the green LED under the generating set symbol flashes and then lights up permanently once the phase is complete.

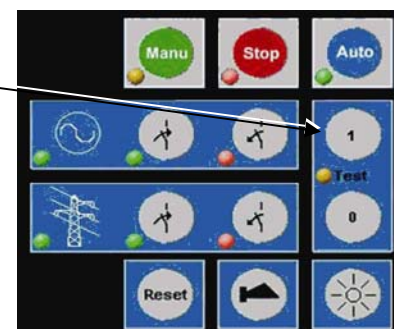


Tests

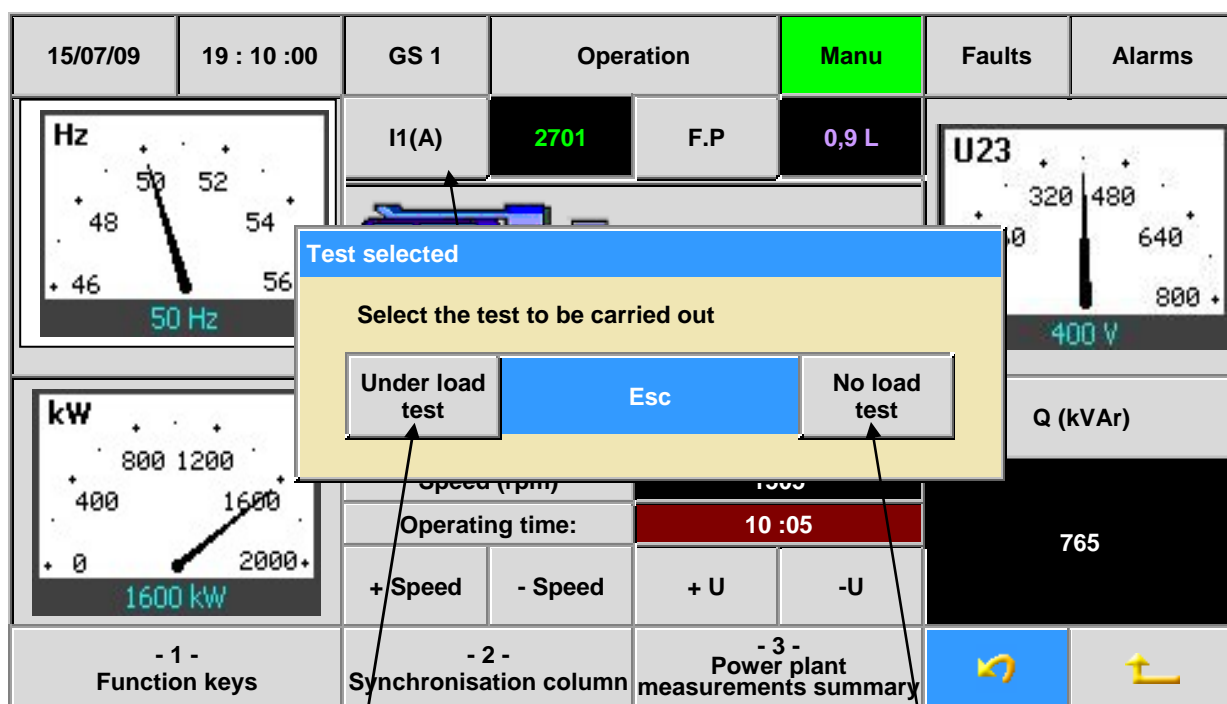
If no faults are present, automatic mode can be activated by pressing **Auto**.



The test starting phase is then initiated after pressing **1** on the test keypad.



Pressing **1** on the test keypad brings up the following window for selecting the test type.

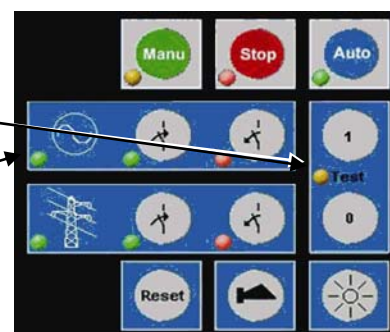


Using the KERYS Tactil Man-Machine Interface, the under load test is started by pressing the corresponding key.

Using the KERYS Tactil Man-Machine Interface, the off load test is started by pressing the corresponding key.

After validation of the test, the **orange LED** on the test keypad lights up steady.

During the start-up phase, and until the alternator voltage and generating set speed stabilise, the **green LED** underneath the symbol for the generating set flashes and becomes steady at the end of this phase.

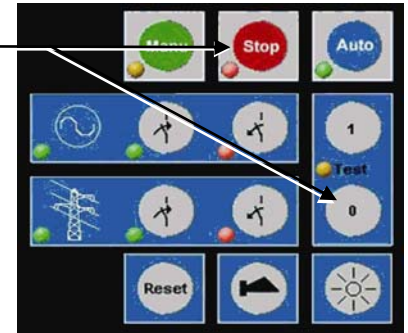



The installation is then controlled via the programmable controller in accordance with the configuration of the application:

- normal/emergency source switchover
- grid coupling
- etc.

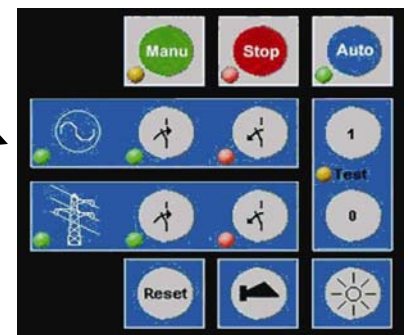
| | |
|------------------|--|
| | <p>The Normal/Emergency switchover with grid coupling is only possible by carrying out a load test. The purpose of the off load test is to start a single GS or to couple a power plant (x generating sets) to the emergency busbar.</p> |
| <p>Important</p> | |

At any time the generating set may be stopped by pressing **Stop** or by pressing **0** on the test keypad.



| | |
|---|--|
|  | <p>Pressing Stop may interrupt the power supply, depending on its status when the key is pressed (e.g. isolated grid operation). The generating set will stop after a cooling delay (180 seconds by default).</p> |
| Important | |

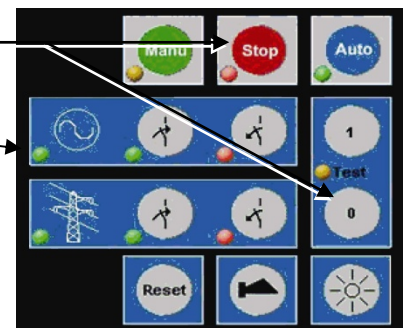
The **green LED** underneath the generating set symbol goes out to indicate that the generating set has stopped.




Switching off

The generating set may be stopped at any time by pressing **Stop** or **0** on the test keypad.

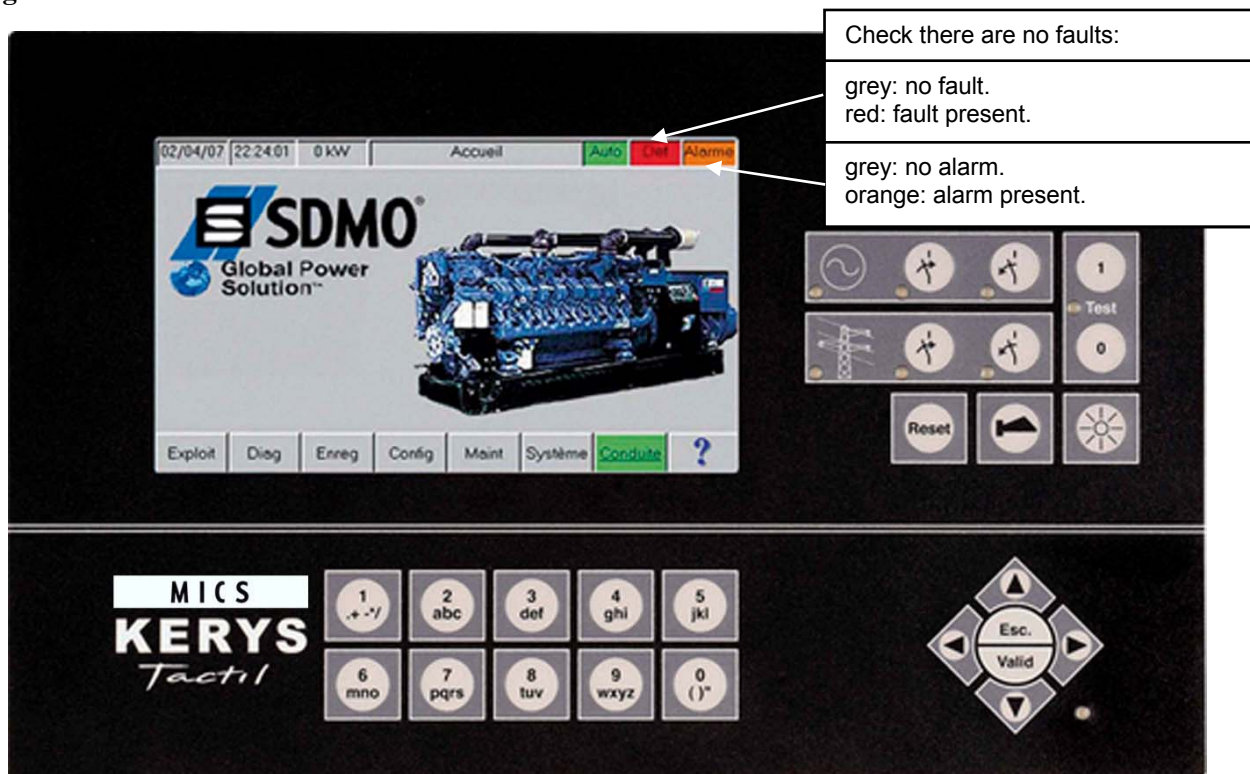
The green LED underneath the generating set symbol goes out to indicate that the generating set has stopped.



| | |
|---|---|
|  | <p>Pressing Stop stops the generating set immediately. Pressing 0 does not stop the generating set immediately (generating set stabilisation time delay).</p> |
| Important | |

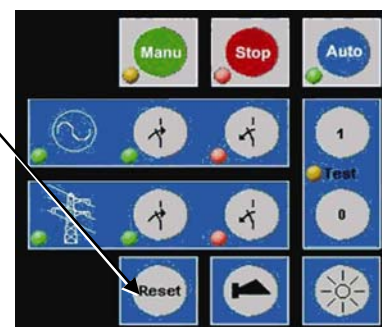
In automatic mode

Starting

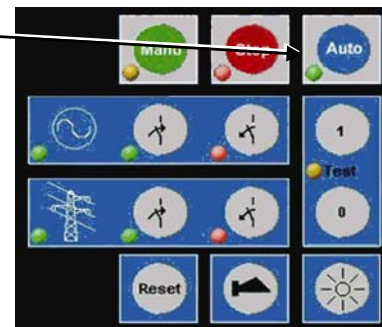


If faults are present, the fault management screen can be accessed by pressing **Reset**.

Refer to the section "Alarms and Faults" in the Operating menus" to eliminate the faults.



If no faults are present, manual mode can be activated by pressing **Auto**.



In AUTO mode, except for the test functions, the generating set starts as a result of an external command which may be triggered by various sources:

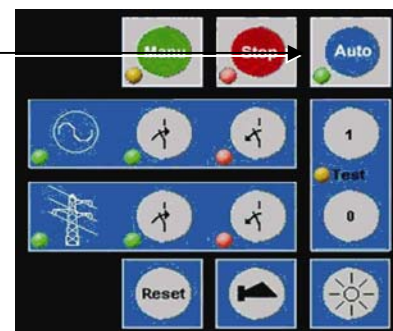
- power loss
- EJP command (France only)
- client command.

The installation is then controlled via the automatic systems in accordance with the configuration of the application:

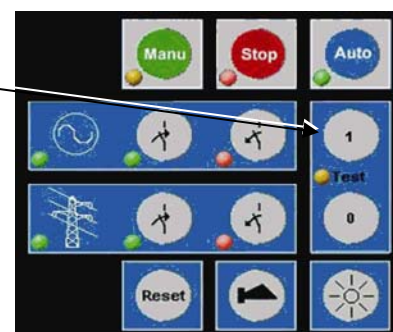
- inversion of normal/emergency source
- grid coupling
- etc.

Tests

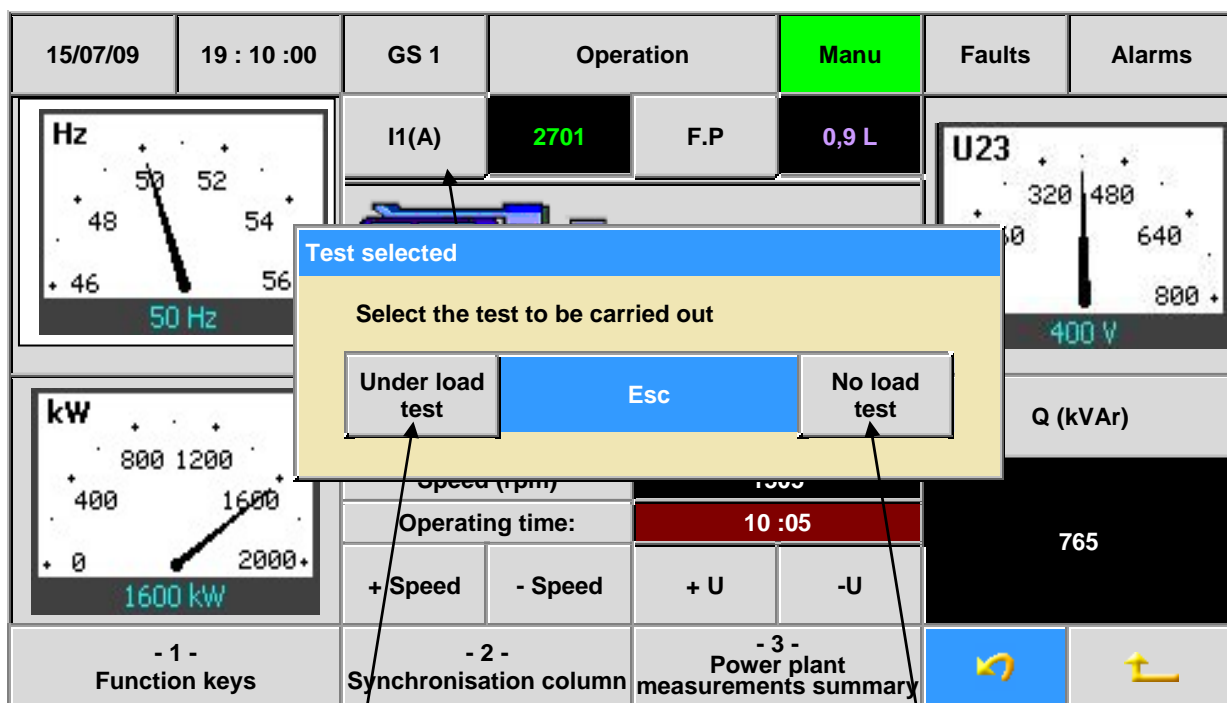
If no faults are present, automatic mode can be activated by pressing **Auto**.



The test starting phase is then initiated after pressing **1** on the test keypad.



Pressing **1** on the test keypad brings up the following window for selecting the test type.

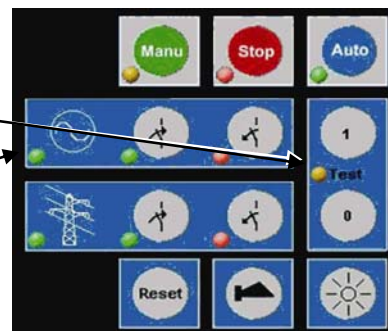


Using the KERYS Tactil Man-Machine Interface, the under load test is started by pressing the corresponding key.

Using the KERYS Tactil Man-Machine Interface, the off load test is started by pressing the corresponding key.


After validation of the test, the **orange LED** on the test keypad lights up steady.

During the start-up phase, and until the alternator voltage and generating set speed stabilise, the **green LED** underneath the symbol for the generating set flashes and becomes steady at the end of this phase.

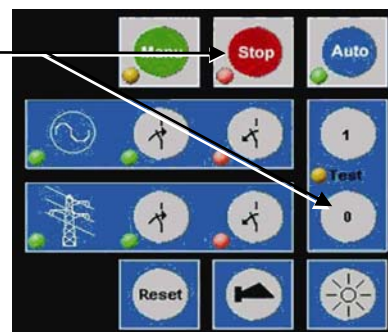



The installation is then controlled via the programmable controller in accordance with the configuration of the application:

- normal/emergency source switchover
- grid coupling
- etc.

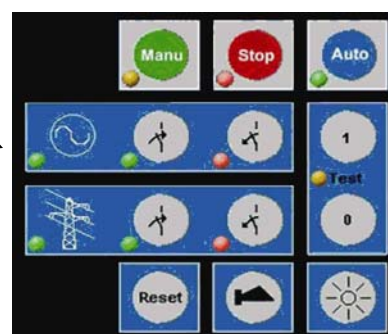
| | |
|--|--|
|  <p>Important</p> | <p>The Normal/Emergency switchover with grid coupling is only possible by carrying out a load test. The purpose of the off load test is to start a single GS or to couple a power plant (x generating sets) to the emergency busbar.</p> |
|--|--|

At any time the generating set may be stopped by pressing **Stop** or by pressing **0** on the test keypad.



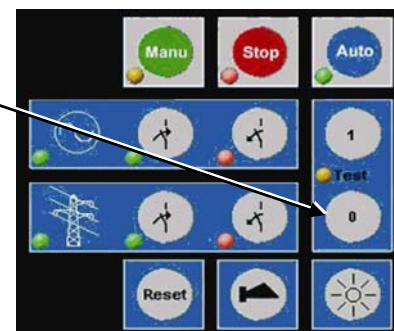
| | |
|--|--|
|  <p>Important</p> | <p>Pressing Stop may interrupt the power supply, depending on its status when the key is pressed (e.g. isolated grid operation). The generating set will stop after a cooling delay (180 seconds by default).</p> |
|--|--|


The **green LED** underneath the generating set symbol goes out to indicate that the generating set has stopped.



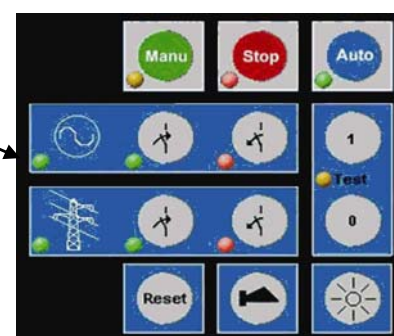
Switching off

The generating set may be stopped at any time by pressing **0** on the test keypad.



| | |
|--|---|
|  <p>Important</p> | <p>Pressing Stop may cause an interruption in the power supply depending on its status when the button is pressed (e.g. isolated grid operation). The generating set will stop after the cooling delay (180 seconds by default).</p> |
|--|---|

The **green LED** underneath the generating set symbol goes out to indicate that the generating set has stopped.



6.3.8.3. Rental options

Damper valve (Optional)

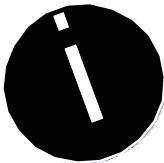
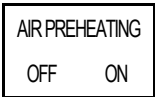
- ❶ If the generating set stops when the valve damper is closed, repair the fault.
- ❷ Display the fault according.
- ❸ Press "Reset" to clear the fault after it has been repaired.



- ❹ If faults persist, repair them.

Air preheating (Optional)

Turn the switch to “ON” to initiate preheating of the generating set.

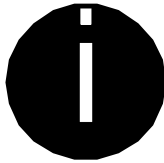
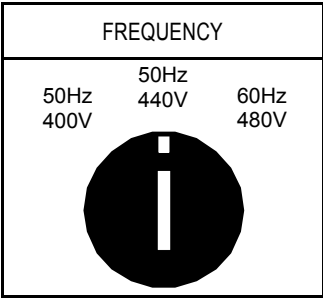


In the case of a power plant, the position of the air preheating switches must **NECESSARILY** be the same on all the switches of the generating sets in the power plant.

Important

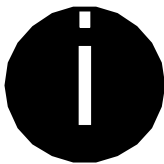
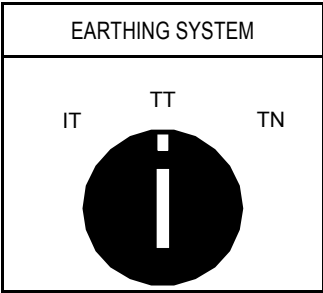
Bi-frequency (Optional)

Turn the switch to the desired frequency and voltage.



Earthing system

Turn the switch to the desired earthing system.



- 1: IT
- 2: TN (TNS)
- 3: TT (TT or EDF APPLICATION)



The EDF earthing system is only used in the so-called rental configurations. The switch must necessarily correspond to the wiring described in the section on “Connection of the generating sets”.

Important

7. Maintenance schedule

7.1. Reminder of use

The maintenance interval frequency and the operations to be carried out are outlined in the maintenance schedule, given as a guideline.

N.B. the environment in which the generating set is operating determines this schedule.

If the generating set is used in extreme conditions, shorter intervals between maintenance procedures should be observed

These maintenance intervals only apply to generating sets running on fuel, oil and coolant which conform to the specifications given in this manual.

7.2. Engine

R = Replace

I = Inspection (includes, if necessary, cleaning, adjustment, lubrication and charge)

First service inspection

| After the first 100 – 200 hours | | | | |
|---|--|--|--|---|
| Fuel pre-filter, draining water / contamination | | | | I |
| Coolant level | | | | I |
| Drive belts | | | | I |
| Start and warm up engine | | | | |
| Coolant / oil / fuel, leakage | | | | I |
| Inspection with VODIA (diagnostic tool) | | | | I |
| Engine and transmission, abnormal noises | | | | I |
| Stop engine | | | | |
| Engine oil and oil filters / by-pass filter | | | | R |
| Restart engine | | | | |
| Oil pressuer / oil leakage | | | | I |

| Every 50 – 600 hours | | At least every (month) | | |
|---|---|------------------------|----|----|
| | | 12 | 24 | 48 |
| Engine oil and oil filters / by-pass filter | R | ● | | |

| After the first 1 000 hours | | | | |
|-----------------------------|--|--|--|---|
| Valve clearance | | | | I |

| Every 500 hours | | At least every (month) | | |
|---|---|------------------------|----|----|
| | | 12 | 24 | 48 |
| Fuel tank (sludge trap), drain | R | ● | | |
| Inspection with VODIA (diagnostic tool) | I | ● | | |
| Fuel pre-filter, draining condensed water | I | ● | | |
| Air filter inserts (indicator), engine | I | ● | | |
| Radiator | I | ● | | |
| Drive belts | I | ● | | |
| Batteries, electrolyte level | I | ● | | |

| Every 1 000 hours | | At least every (month) | | |
|---|---|------------------------|----|----|
| | | 12 | 24 | 48 |
| Fuel filter | R | ● | | |
| Air filter insert | R | ● | | |
| Fuel pre-filter | R | ● | | |
| Coolant filter (if fitted). Not at same time as coolant change. | R | ● | | |

| Every 2 000 hours | | | | |
|-------------------|--|--|--|---|
| Valve clearance | | | | I |

| Every 2 000 hours | | At least every (month) | | |
|---------------------------------|---|------------------------|----|----|
| | | 12 | 24 | 48 |
| Turbo | I | | ● | |
| Turbo, Wastegate | I | | ● | |
| Engine, with respect to leakage | I | | ● | |
| Engine hoses, cables and clamps | I | | ● | |
| Engine, cleaning and painting | I | | ● | |
| Air filter, tank breather | R | | ● | |
| Air filter compressor | R | | ● | |


| Every 4 000 hours | | At least every (month) | | |
|-------------------|---|------------------------|----|----|
| | | 12 | 24 | 48 |
| Belt tensioner | I | | ● | |
| Drive belt | R | | ● | |
| Coolant (green) | R | | ● | |

| Every 8 000 hours | | At least every (month) | | |
|----------------------|---|------------------------|----|----|
| | | 12 | 24 | 48 |
| Coolant VCS (yellow) | R | | | ● |

7.3. Alternator

- ✓ After 20 hours in operation, check the tightness of all the mounting bolts, the general condition of the machine and the various electrical connections of the installation.
- ✓ The bearings fitted on the machine are greased for life to around the service life of the grease (depending on use) = 20 000 hours or 3 years.
- ✓ Regularly clean the inlet and outlet grid.

8. Battery

| | |
|---|--|
|  | <p>Fit the battery so that it is properly ventilated.</p> <p>Maintenance should only be carried out by qualified personnel.</p> <p>If replacing the batteries, use the same type of batteries. Do not throw the old battery in the fire.</p> <p>Only use insulated tools (the operator should not be wearing a watch, chain or any metal object).</p> <p>Never use sulphuric acid or acid water to top up the electrolyte level. Use an approved battery fluid.</p> <p>Batteries release oxygen and hydrogen gas, which are flammable.</p> <p>Never bring flames or sparks near the battery (risk of explosion).</p> <p>Discharge any static electricity before handling the batteries by first touching an earthed metal surface.</p> <p>Do not use the battery when the fluid level is below the minimum required level. Using a battery with a low electrolyte level could result in an explosion.</p> <p>Do not short the battery terminals with a tool or other metal object.</p> <p>When disconnecting battery cables, remove the cable from the negative (-) terminal first. When reconnecting the battery, connect the positive lead (+) first.</p> <p>Charge the battery in a well-ventilated place, with all the filler caps opened.</p> <p>Ensure that the battery terminals are correctly tightened. A loose cable clamp can cause sparks that could result in an explosion.</p> |
| <p>Danger</p> | <p>Before servicing electrical components or performing electric welding, set the battery switch to the [OFF] position or disconnect the battery negative cable (-) to cut off the electrical current.</p> <p>Electrolyte contains dilute sulphuric acid. Careless handling of the battery causing contact with sulphuric acid could damage your eyesight or cause burns.</p> <p>Wear safety goggles and rubber gloves when working with the battery (topping-up fluid, charging, etc.)</p> <p>If electrolyte comes into contact with your skin or clothes, wash it off immediately with plenty of water, then carefully wash the area with soap.</p> <p>If electrolyte comes into contact with your eyes, rinse immediately with plenty of water and seek medical attention as soon as possible.</p> <p>If electrolyte is accidentally swallowed, gargle with plenty of water and drink large quantities of water. Consult a doctor immediately.</p> <p>Large quantities of electrolyte should be rinsed off using a neutralising agent. A common method is to use a solution of 500g of bicarbonate of soda diluted in 4 litres of water. The bicarbonate of soda solution should be added until the reaction has finished (lather). The remaining liquid should be rinsed off with water and left to dry.</p> |

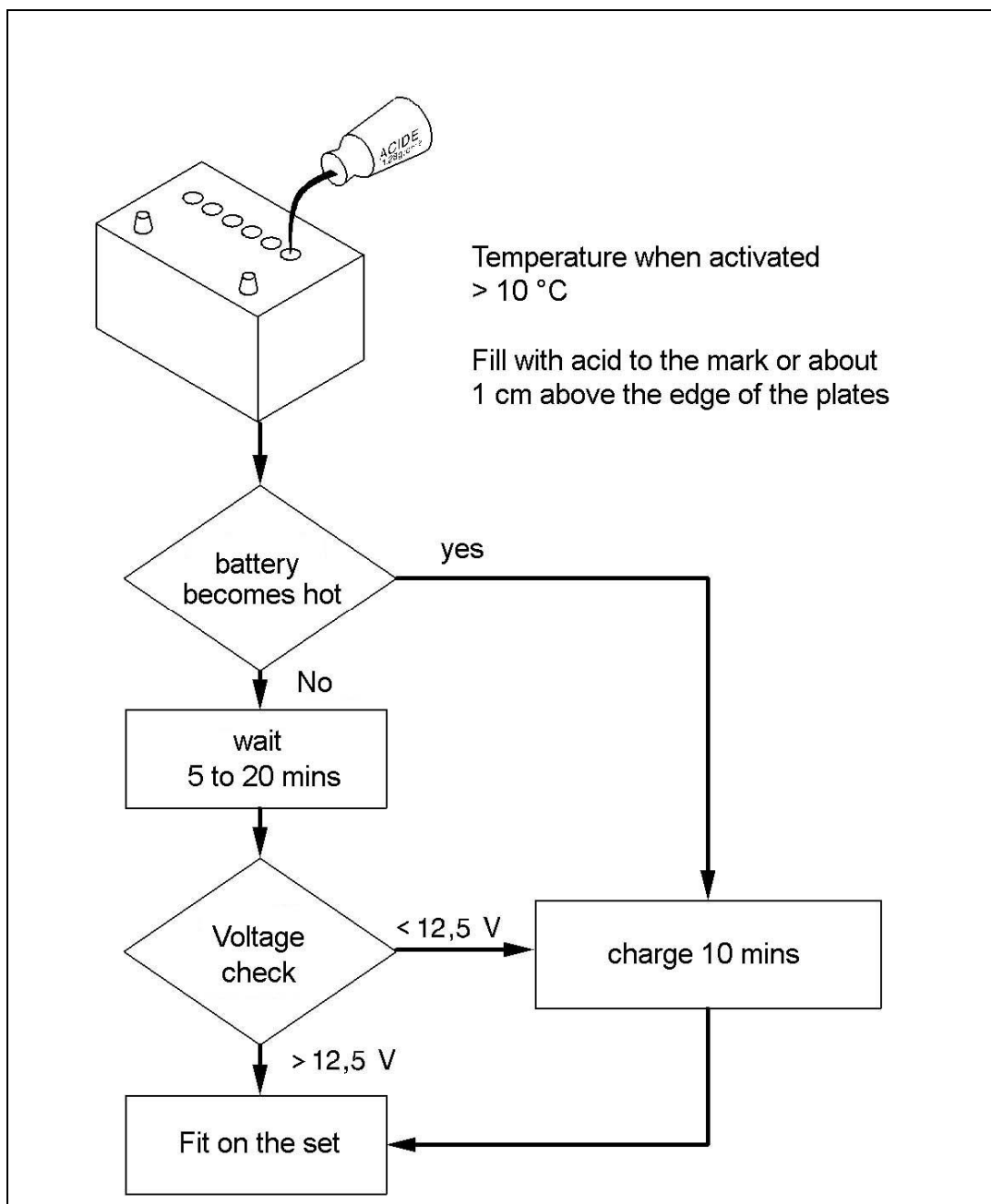
- ✓ Dry batteries do not require any servicing
- ✓ Batteries ready for use must be recharged at the latest when the acid density drops below 1.20.

8.1. Storage and transport

- ✓ Batteries ready for use must be stored in a cool and dry place (frost-free) protected from the sun (self-discharge).
- ✓ Batteries must be transported and stored vertically (risk of acid spillage)
- ✓ Leave the terminal cover on the positive terminal

8.2. Battery setting into service

- ✓ Batteries filled with acid have a density of 1.28 g/ml and are charged.
- ✓ In the case of dry batteries, fill each battery cell with acid up to the maximum level mark or to 15 mm above the plates. Let the battery rest for 20 minutes.
- ✓ Before fitting the battery, stop the engine and any power consumer, clean the terminals and give them a light coating of grease. When connecting, connect the positive terminal (+) first, and then the negative terminal (-).



8.3. Check

| Acid density | Charge status | Voltage when idle | |
|--------------|---------------|-------------------|--------------------|
| 1.27 | 100% | Above 12.60 V | |
| 1.25 | 80% | 12.54 V | |
| 1.20 | 60% | 12.36 V | From 50 % recharge |
| 1.19 | 40% | 12.18 V | Risk of sulphation |
| 1.13 | 20% | Under 11.88 V | Unusable |

8.4. Load preconization

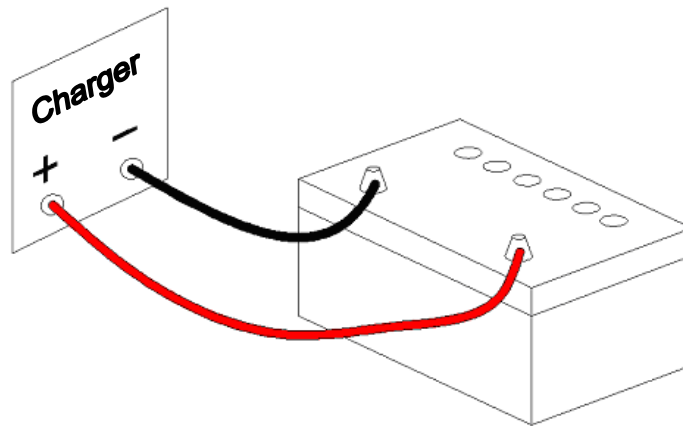
- ✓ Highly discharged or sulphated batteries (formation of whitish lead sulphate deposit on the plates, which becomes hard and insoluble to acid; this deposit reduce the active surface of the plates, and increases their internal resistance) can no longer regenerate or be charged in a generating set.



Important

A discharged battery should be recharged immediately, or else it will suffer irreparable damage.

Battery charge



When several batteries are connected together, the following points should be checked:

- ✓ Are the batteries connected in series?
- ✓ Has the correct voltage been chosen? 1 battery x 12 V , 3 x 36V batteries.
- ✓ Adjust the charge current to the lowest battery.
- ✓ The power difference between the batteries must be as low as possible.

Example of charge:

- ✓ 12V 60 Ah battery = charging current 6 A.
- ✓ Charge status: 50% (acid density 1.21/voltage when idle 12.30V).
- ✓ The battery is short 30 Ah, and this must be recharged.
- ✓ Charge factor: 1.2.
- ✓ Ah x 1.2 = 36 Ah to be charged.
- ✓ Charging current: 6A approximately 6 hours charging required.

Recharging is complete when the battery voltage and the acid density stop increasing.

→ The charging current must always be $1/10^{\text{th}}$ of the nominal capacity of the battery.

The power of the charger must be suitable for the battery to be charged and the charging time available.

You need to use an automatic charger able to provide a sufficient voltage and charging current, as well as a compensation voltage to handle spontaneous battery discharge.

8.5. Faults and remedies

| Fault observed | Probable origin | Measures or observations |
|---|---|---|
| The acid heats up when a new battery is filled | <ul style="list-style-type: none"> - Incorrect composition - Incorrect storage - Prolonged storage in a damp place | <ul style="list-style-type: none"> - Cool - Charge - Check the acid density |
| The acid escapes through the filler holes | <ul style="list-style-type: none"> - Battery overflow during filling | <ul style="list-style-type: none"> - Reduce the battery fluid level |
| Acid level too low | <ul style="list-style-type: none"> - Battery tray not leaktight - Significant gas formation caused by too high a charging voltage | <ul style="list-style-type: none"> - Replace the battery - Check the charger and repair if necessary. |
| Acid level too low Incorrect operation from start-up | <ul style="list-style-type: none"> - Insufficient charge - Short circuit in the current circuit - Consumption fault | <ul style="list-style-type: none"> - Recharge - Check the electrical installation |
| Acid density too high | <ul style="list-style-type: none"> - The battery has been filled with acid instead of water | <ul style="list-style-type: none"> - Reduce the acid level and fill with distilled water. Repeat the operation if need be. |
| Starting problems Starting test incorrect | <ul style="list-style-type: none"> - Battery empty - Battery used up or faulty - Capacity too low - Battery sulphated | <ul style="list-style-type: none"> - Recharge the battery - Fit a new battery |
| Battery terminals melted | <ul style="list-style-type: none"> - Incorrect electrical connection - Incorrect battery wiring | <ul style="list-style-type: none"> - Tighten the ends of the battery cables, or replace them if necessary |
| One or two cells release a lot of gas at high charge | <ul style="list-style-type: none"> - Cell(s) faulty | <ul style="list-style-type: none"> - Fit a new battery |
| The battery discharges very quickly | <ul style="list-style-type: none"> - Charge status too low - Short circuit in the current circuit - High self-discharge (for example: through electrolyte contamination) - Sulphation (storage of discharged battery) | <ul style="list-style-type: none"> - Check the charge - Replace the battery |
| Short service life | <ul style="list-style-type: none"> - Incorrect battery part no. - Too many repeated deep discharges - Battery stored too long without charge | <ul style="list-style-type: none"> - Define the correct battery part no. for the recommended use - Think about charging the battery using a regulator |
| High water consumption | <ul style="list-style-type: none"> - Overload - Charging voltage too high | <ul style="list-style-type: none"> - Check the charger (voltage regulator) |
| The battery explodes | <ul style="list-style-type: none"> - Spark after battery charging - Short circuit - Connection or disconnection during charging - Internal fault (for example: interruption) and low electrolyte level | <ul style="list-style-type: none"> - Replace the battery (beware of fire and sparks) - Ensure there is sufficient ventilation |

9. Appendix

9.1. Appendix A – Engine user and maintenance manual

User guide and maintenance manual

VOLVO

Engine

TAD940VE

TAD941VE

TAD942VE

TAD943VE

TAD940GE

TAD941GE

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01/01/2012

33522062701_2_1

OPERATOR'S MANUAL

**Generating set and industrial engines
9 liter (EMS 2)**

ENG This Operator's Manual may be ordered in a different language free of charge up to 12 months after delivery, via internet.

<http://vppneuapps.volvo.com/manual/coupon/>

If internet access isn't possible, please contact your Volvo Penta dealer.

GER Diese Betriebsanleitung kann bis zu 12 Monate nach der Lieferung über Internet kostenlos in einer anderen Sprache bestellt werden.

<http://vppneuapps.volvo.com/manual/coupon/>

Wenn Sie keinen Internet-Zugriff haben, kontaktieren Sie bitte Ihren Volvo Penta-Händler.

FRE Ce manuel d'utilisation peut être commandé gratuitement sur Internet en différentes langues, jusqu'à 12 mois après la date de livraison.

<http://vppneuapps.volvo.com/manual/coupon/>

Veuillez contacter votre Distributeur Volvo Penta si vous avez un problème d'accès à l'Internet.

SPA El presente libro de instrucciones puede solicitarse en otro idioma diferente, libre de cargo, hasta 12 meses después de la entrega, mediante internet.

<http://vppneuapps.volvo.com/manual/coupon/>

Si no se tiene acceso a internet, contacten al su concesionario Volvo Penta.

ITA Il manuale per l'operatore può essere ordinato tramite Internet, in varie lingue e per consegna gratuita, entro 12 mesi dalla consegna del prodotto

<http://vppneuapps.volvo.com/manual/coupon/>

Se l'accesso a Internet risulta impossibile, contattare la concessionaria Volvo Penta.

SWE Denna instruktionsbok kan beställas via internet på ett annat språk gratis i upp till 12 månader efter leverans.

<http://vppneuapps.volvo.com/manual/coupon/>

Kontakta din Volvo Penta-återförsäljare om du inte har tillgång till internet.

DUT Dit instructieboek kan gratis via internet in een andere taal worden besteld tot 12 maanden na aflevering.

<http://vppneuapps.volvo.com/manual/coupon/>

Als toegang tot het internet niet mogelijk is, neem dan contact op met uw Volvo Penta dealer.

DAN Denne instruktionsbog kan bestilles gratis på et andet sprog via Internettet i op til 12 måneder efter leveringen.

<http://vppneuapps.volvo.com/manual/coupon/>

Hvis det ikke er muligt at bestille via Internettet, bedes du kontakte din Volvo Penta forhandler.

FIN Tämä käyttöohjekirja on tilattavissa Internetin kautta veloituksetta eri kielillä 12 kuukauden ajan toimituksen jälkeen.

<http://vppneuapps.volvo.com/manual/coupon/a>

Jos sinulla ei ole Internet-yhteyttä, ota yhteys lähimpään Volvo Penta jälleenmyyjään.

POR Este Manual do Operador pode ser encomendado em idiomas diferentes isento de custos até 12 meses após entrega, via internet.

<http://vppneuapps.volvo.com/manual/coupon/>

Se não for possível aceder à internet, contacte o seu concessionário Volvo Penta.

GRE Το παρόν Βιβλίο Χρήσης μπορεί να παραγγελθεί δωρεάν σε άλλη γλώσσα μέχρι 12 μήνες μετά την παράδοση, μέσω διαδικτύου.

<http://vppneuapps.volvo.com/manual/coupon/>

Εάν δεν είναι δυνατή η πρόσβαση στο διαδίκτυο, παρακαλούμε επικοινωνήστε με το δικό σας

RUS Данное руководство по эксплуатации можно бесплатно заказать на другом языке по Интернету в течение 12 месяцев после доставки.

<http://vppneuapps.volvo.com/manual/coupon/>

Если доступ к Интернету отсутствует, обратитесь к своему дилеру компании Volvo Penta.

TUR Bu Kullanım Kılavuzu, teslimden 12 ay sonrasına kadar İnternet yoluyla ücretsiz olarak farklı bir dilde sipariş edilebilir.

<http://vppneuapps.volvo.com/manual/coupon/>

İnternet mümkün değilse, lütfen Volvo Penta yetkili satıcınızla tmasa geçin.

CHI 本操作手册可通过互联网以不同的言进行订购，交付后可免费使用达12个月。

<http://vppneuapps.volvo.com/manual/coupon/>

如果无法访问互联网，请与沃尔沃遍达经销商联系。

CALIFORNIA PROPOSITION 65 WARNING

Engine exhaust, some of its constituents, and a broad range of engine parts are known to the State of California to cause cancer, birth defects, and other reproductive harm. Additionally, lubricants, fuels, and other fluids used in engines—including any waste created through the wearing of engine parts—contain or produce chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

Battery posts, terminals, and related accessories contain lead and lead compounds. Wash your hands after handling. Used engine oil contains chemicals that have caused cancer in laboratory animals. Always protect your skin by washing thoroughly with soap and water.

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Foreword

Volvo Penta engines are used all over the world. They are used in all possible operating conditions. This is not a coincidence. After 100 years as an engine manufacturer the Volvo Penta name has become a symbol of reliability, technical innovation, top of the range performance and long service life. We also believe that this is what you demand and expect of your Volvo Penta engine.

We would like you to read this operator's manual thoroughly and consider the advice we give on running and maintenance. Please pay attention to the safety instructions contained in the manual.

As owner of a Volvo Penta engine, we would also like to welcome you to a worldwide network of dealers and service workshops to assist you with technical advice, service requirements and replacement parts. Please contact your nearest authorized Volvo Penta dealer for assistance.

You will find your closest dealer at our home page on the Internet www.volvopenta.com - amongst other useful information about your Volvo Penta engine - we invite you to visit!

Safety Information

Read the Operators Manual through very carefully before you start the engine or do any maintenance or service. It has to do with your safety, an incorrect operation can lead to personal injury and damage to products or property. This chapter describes how safety precaution is presented in the Operators Manual and on the product. It also gives you an introduction to the basic safety rules for using and looking after the engine.

If there is still something which is unclear or if you feel unsure about it, please contact your Volvo Penta dealer for assistance.

NOTICE! Check that you have received the correct operator's manual before you read on. If not, please contact your Volvo Penta dealer.



This symbol is used in the Operators Manual and on the product, to call your attention to the fact that this is safety information. Always read such information very carefully.

Safety texts in the Operators Manual have the following order of priority:



DANGER!

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.



WARNING!

Indicates a hazardous situation which, if not avoided, could result in death or serious personal injury.



CAUTION!

Indicates a hazardous situation which, if not avoided, could result in minor or moderate personal injury.

IMPORTANT!

Indicates a situation which, if not avoided, could result in property damage.

NOTICE! Used to draw your attention to important information that will facilitate the work or operation in progress.



This symbol is used on our products in some cases and refers to important information in the Operators Manual. Make sure that warning and information symbols on the engine are clearly visible and legible. Replace symbols which have been damaged or painted over.

Safety rules for operation and maintenance

Daily checks

Make it a habit to give the engine and engine bay a visual check before starting (**before the engine is started**) and after operation (**once the engine has stopped**). This helps you to quickly discover whether any leakage of fuel, coolant, oil or any other abnormal event has happened, or is about to happen.

Carbon monoxide poisoning

Only start the engine in a well ventilated area. When operated in a confined space, exhaust fumes and crankcase gases must be ventilated.

Cooling System

Avoid opening the coolant filling cap when the engine is hot. Steam or hot coolant can spray out and cause scalding, at the same time as the pressure built up is lost.

If the filler cap, coolant hose etc., still has to be opened or removed when the engine is hot, undo the filler cap slowly and carefully, to let the pressure out before removing the filler cap completely and starting work. Note that the coolant can still be hot and cause scalding.

Fuel and lubrication oils

Always protect your hands when searching for leaks. Fluids which leak under pressure can force their way into body tissue and cause severe injury. There is a risk of blood poisoning (septicemia).

Only use the fuel recommended in the Operators Manual. The wrong grade of fuel can cause malfunctions or stop the engine. In a diesel engine, it can also cause the injection pump to seize and the engine will over-rev, entailing a strong risk of personal injury and machinery damage.

Always cover the alternator if it is located beneath the fuel filters. Fuel spillage can damage the alternator.

Always change the oil, oil filter and fuel filter at the specified intervals.

Starting lock

If the instrument panel does not have a key switch, the engine room must be lockable, to prevent unauthorized persons from starting the engine. Alternatively, a lockable main switch can be used.

Hot surfaces and fluids

A hot engine always increases the risk for burns. Be on your guard against hot surfaces: the exhaust manifold, turbocharger, oil pan, charge air pipe, starting heater, hot coolant and hot lubricating oil in pipes, hoses etc.

Fuel filling

There is always a risk of fire and explosion during fuel filling. Smoking is forbidden, and the engine should be stopped.

Never overfill the tank. Shut the tank cap securely.

Only use the fuel recommended in the instruction book. The wrong grade of fuel can cause serious malfunctions, power loss or stop the engine.

Operation

The engine must not be operated in environments which contain explosive media since none of the electrical and mechanical components are explosion proof.

Going close to a running engine is a safety risk. Hair, fingers, loose clothes, or dropped tools can catch on rotating components and cause severe injury.

When engines are supplied without touch guards, all rotating components and hot surfaces must be protected after installation in their application, if necessary for personal safety.

Care and maintenance

Knowledge

The Operators Manual contains instructions for doing the most common service and maintenance tasks in a safe and correct manner. Read them carefully before starting work.

Literature for more major tasks is available from your Volvo Penta dealer.

Never do a job if you are not entirely sure about how to do it. Please contact your Volvo Penta dealer and ask for assistance instead.

Stopping the engine

Stop the engine before opening or removing the engine hatch/hood. Service and maintenance work should be done with the engine stopped unless otherwise specified.

Prevent the engine from being started by pulling out the starter key and disconnect the power with the main switch. Lock them in the "Off" position.

If the instrument panel does not have a key switch, remove the system voltage with the main switch. Fix a notice by the operator position to say that work is in progress.

Working with, or approaching a running engine is a safety risk. Hair, fingers, loose clothes, or dropped tools can catch on rotating components and cause severe injury. Volvo Penta recommends that all service work which requires the engine to be running should be done by an authorized Volvo Penta workshop.

Fire and explosion

Fuel and lubrication oil

All fuel, most lubricants and many chemicals are flammable. Always read and observe the advice on the packages.

Work on the fuel system must be done with the engine cold. Fuel leakage and spills on hot surfaces or electrical components can cause fires.

Store oil and fuel soaked rags and other flammable material in a fireproof manner. Oil soaked rags can self-ignite in certain circumstances.

Never smoke when filling fuel, lubrication oil or when close to fuel filling stations or the engine bay.

Spare parts

Components in fuel systems and electrical systems on Volvo Penta engines are designed and manufactured to minimize the risk of explosions and fire, in accordance with applicable legal requirements.

The use of spare parts not approved by Volvo Penta can cause an explosion or fire.

Before starting

Re-install all guards which have been removed during service work, before re-starting the engine. Make sure that there are no tools or other objects left behind on the engine.

Never start a turbocharged engine without the air filter in place. The rotating compressor turbine in the turbocharger can cause severe injury. There is also a risk that foreign bodies could be sucked in and cause damage to the machinery.

Lifting the engine

The lifting eyes fitted on the engine should be used for lifting. Always check that the lifting devices are in good condition and that they have the correct capacity for the lift (engine weight together with auxiliaries, if fitted). The engine should be lifted with an adjustable lifting boom for safe handling. All chains or cables should be parallel to each other and should be as square as possible to the top of the engine. Please note that auxiliary equipment installed on the engine could change its center of gravity. Special lifting devices may then be needed to obtain the correct balance and safe handling. Never carry out work on an engine that is **only** suspended in a hoist.

Batteries

Batteries contain and give off an explosive gas, especially when charged. This gas is very flammable and highly explosive.

Smoking, open flames or sparks must never occur in or near to batteries or the battery locker.

Incorrect connection of a battery cable or start cable can cause a spark which can be sufficient, in its turn, to make the battery explode.

Start spray

Never use start spray or similar preparations to help in starting an engine with air pre-heating (glow plugs / starting heater). They may cause an explosion in the inlet manifold. Danger of personal injury.

Electrical System

Disconnect the power

Before any work is done on the electrical system, the engine must be stopped and the power removed by switching off the main switch(es). Any external power supply for engine heaters, battery chargers or other auxiliary equipment connected to the engine must be disconnected.

Electric welding

Remove the positive and negative cables from the batteries.

Then disconnect all cables connected to the alternator. Disconnect both connectors from the engine control module.

Always connect the welder earth clamp to the component to be welded, and as close as possible to the weld site. The clamp must never be connected to the engine or in such a way that current can pass through a bearing.

When welding is completed: Always connect the cables to the alternator **and engine control unit connector before** reconnecting the battery cables.

Batteries

Batteries contain a highly corrosive electrolyte. Protect your eyes, skin and clothes during charging and other handling of batteries. Always use protective goggles and gloves.

If acid comes into contact with your skin, wash at once with soap and a lot of water.

If you get battery acid in your eyes, flush at once with a lot of cold water, and get medical assistance at once.

Introduction

The Operator's Manual contains the information required for the correct, safe operation and maintenance of your Volvo Penta engine. We recommend therefore that you read the manual carefully and learn to handle the engine and other equipment in a safe manner before starting the engine.

The Operator's Manual describes the engine and equipment sold by Volvo Penta. The specifications, design information and illustrations used in the Operator's Manual are not definitive. We reserve the right to make changes without prior notice.

Differences in appearance and function of the controls and instruments may occur in certain variants. In such cases, refer to the Operator's Manuals for the applications concerned.

When ordering service or spares, always specify the engine and transmission identification number. Refer to *Technical Data* page 76.

Warranty

Your new Volvo Penta industrial engine is covered by a limited warranty, according to the conditions and instructions compiled in the Warranty and Service book.

Note that AB Volvo Penta's liability is limited to that which is described in the Warranty and Service Book. Read it carefully, as soon as possible after delivery. It contains important information about the warranty card, service intervals and maintenance that the owner must be aware of, check and perform, otherwise AB Volvo Penta may disclaim its warranty obligations in part or in full.

Contact your Volvo Penta dealer if you have not received a Warranty and Service book, or a customer copy of the warranty card.

Breaking in

The engine must be broken in during its first 10 operating hours, as follows:

Run the engine in normal operations. However, full load may not be applied other than for short periods. Never run the engine for long stretches at constant speeds during this period.

Higher oil consumption is normal during the first 100-200 hours of operation. For this reason, check the oil level more frequently than the normal recommendation.

When an disengageable clutch is installed, it should be checked more carefully during the first days.

Adjustments may be necessary to compensate bedding-in of the friction plates.

Maintenance and replacement parts

Volvo Penta engines are designed for maximum reliability and long life. They are not only built to withstand a demanding environment, but also to have the smallest possible environmental impact. These qualities will be maintained through regular servicing and the use of genuine Volvo Penta replacement parts or replacement parts approved by Volvo Penta.

Volvo Penta has a world-wide network of authorized dealers. They are Volvo Penta product specialists, and have the accessories, genuine parts, test equipment and special tools needed for high quality service and repair work.

Always observe the maintenance intervals in the manual, and remember to note the engine/transmission identification number when you order service and spare parts.

Fuel, oils and coolant

Only use fuel and oils of the grades recommended in the Operator's Manual. Other grades may cause operational malfunctions, increased fuel consumption and over time even shorten the life of the engine. Always change the oil, oil filter and fuel filter at the specified intervals.

Future warranty claims related to the engine and accessories may be declined if an unsuitable coolant has been used, or if the instructions for coolant mixture have not been followed.

Environmental care

All of us like to live in a clean, healthy environment, where we can breathe clean air, see healthy trees, have clean water in lakes and seas, and enjoy sunlight without fearing for our health. Unfortunately, this cannot be taken for granted these days but it is something we all must work to achieve.

Volvo Penta has special responsibility as an engine manufacturer, and for this reason environmental care is a natural cornerstone of our product development. Volvo Penta currently has a broad engine program in which great progress has been made in reducing exhaust emissions, fuel consumption and engine noise etc.

We hope that you will be keen to preserve these qualities. Always follow the directions in the Operator's Manual about fuel grades, operation and maintenance, to avoid unnecessary environmental effects. Contact your Volvo Penta dealer if you notice any changes such as increased fuel consumption or increased exhaust smoke.

Remember always to hand in environmentally hazardous waste such as drained oil, coolant, old batteries, etc. for treatment at a recycling facility.

Our united efforts can make a valuable contribution to the environment.

Certified engines

If you own an emission-certified engine used in an area where exhaust emissions are regulated by law, it is important to be aware of the following:

Certification means that an engine type has been checked and approved by the relevant authority. The engine manufacturer guarantees that all engines of the same type conforms to the certified engine.

This places special demands on the care and maintenance you provide your engine in that

- the maintenance and service intervals recommended by Volvo Penta must be complied with.
- Only genuine Volvo Penta replacement parts may be used.
- Service on injection pumps, pump settings and injectors must always be carried out by an authorized Volvo Penta workshop.
- The engine must not be converted or modified, except with accessories and service kits that Volvo Penta has developed for the engine.
- No installation changes to the exhaust pipe and engine air inlet ducts may be made.
- Any warranty seals may be broken only by authorized persons.

The general instructions in the Operator's Manual concerning operation, service and maintenance apply.

NOTICE! Neglected or poorly performed maintenance/service, as well as the use of non-genuine replacement parts, will mean that AB Volvo Penta can no longer guarantee that the engine conforms to the certified model.

Damages and/or costs arising from this will not be compensated by Volvo Penta.

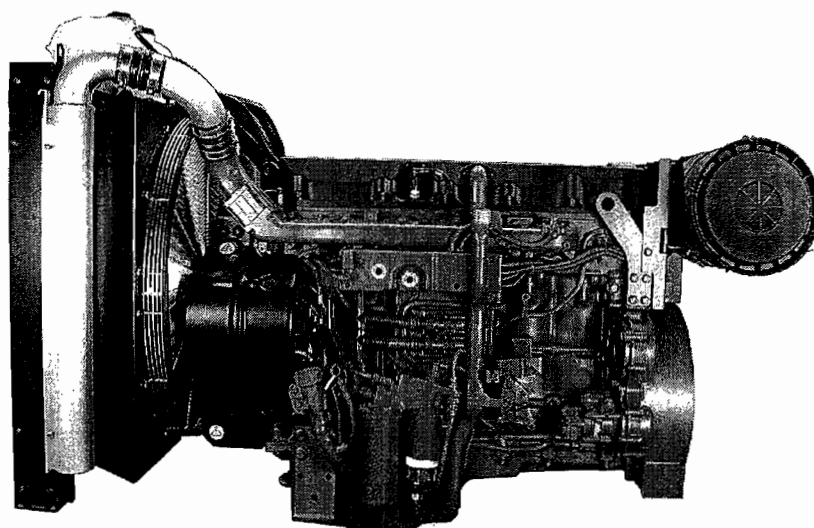
Presentation

Engines

This Operator's Manual contains descriptions and maintenance instructions for TAD940GE, TAD941GE, TAD940VE, TAD941VE, TAD942VE, TAD943VE, TAD950VE, TAD951VE and TAD952VE industrial diesel engines.

They are 6-cylinder in-line engines with direct injection. All engines are equipped with electronically controlled fuel management (EMS 2), turbocharger, charge air cooler, thermostatically controlled cooling systems and electronic speed control.

TAD950VE, TAD951VE have TAD952VE are also equipped with internal EGR (Exhaust Gas Recirculation).



EMS (Engine Management System)

EMS (Engine Management System) is an electronic system with CAN communication (Controller Area Network) for diesel engine control. The system was developed by Volvo Penta and includes fuel control and diagnostic function.

Input signals

The control unit receives input signals about engine operating conditions, etc. from the following components:

- coolant temperature sensor
- charge air pressure and charge air temperature sensor
- crankcase pressure sensor
- position sensor, camshaft
- speed sensor, flywheel
- coolant level sensor
- oil level and temperature sensor
- oil pressure sensor
- fuel pressure sensor
- water in fuel indicator

Diagnostics function

The purpose of the diagnostic function is to detect and locate any malfunctions in the EMS system, to protect the engine and to ensure operation in the event of serious malfunction.

If a malfunction is detected, it is announced by warning lamps, a flashing diagnostic lamp or in plain language on the instrument panel, depending on the equipment used. If a fault code is provided as a flashing code or in plain language, it is used for guidance in any fault tracing. Fault codes can also be read by Volvo's Vodia tool at authorized Volvo Penta workshops.

If there is a serious malfunction, the engine will be shut down altogether, or the control unit will reduce the power delivered (depending on the application). Once again, a fault code is set for guidance in any fault tracing.

Output signals

The control module uses input signals to control the following components:

- unit injectors
- starter motor
- main relay
- pre-heating relay

Information from the sensors provides exact information about current operation conditions and allows the processor in the control unit to calculate the correct fuel injection volume and timing, check engine status etc.

Fuel control

The engine fuel requirement is analyzed up to 100 times per second. The amount of fuel injected into the engine and the injection advance are fully electronically controlled via fuel valves in the unit injectors.

This means that the engine always receives the correct volume of fuel in all operating conditions, which offers lower fuel consumption, minimal exhaust emissions etc.

Instruments and Controls

DCU (Display Control Unit)

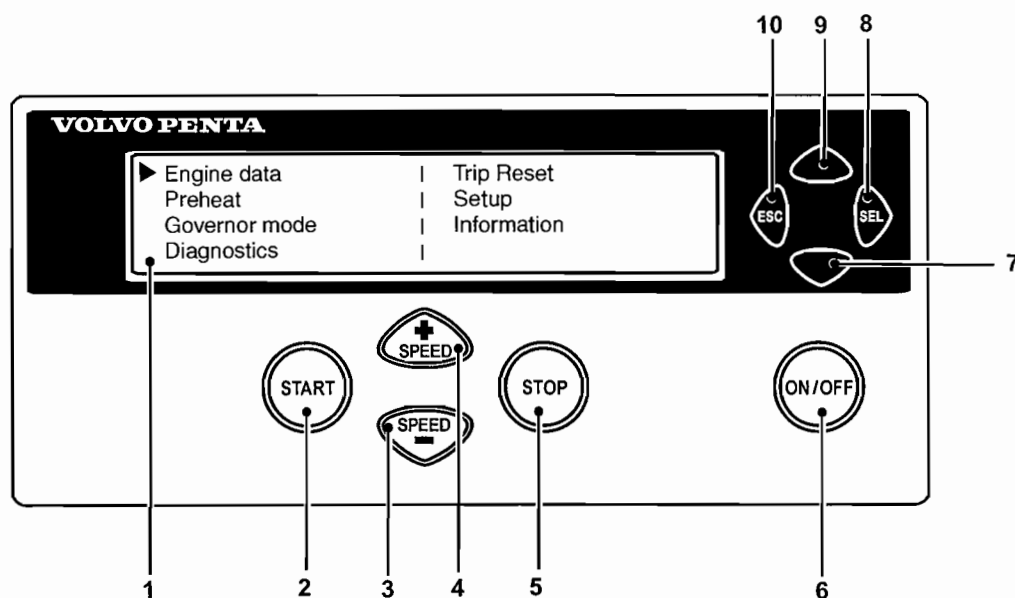
The DCU (Diesel Control System) control panel is available as an optional accessory for the EMS (Engine Management System) electronic control system.

The DCU is a digital instrument panel which communicates with the engine control unit. The DCU has several functions, such as engine control, monitoring, diagnostics, and parameter setting.

The menus in the DCU system can be used to check, and in some cases to set, a number of different functions in the EMS system.

NOTICE! Settings and what engine data that appears in the display may vary depending on installation and engine model.

NOTICE! The menus and illustrations shown here are the English version. The language can be changed, however; refer to the *Setup* menu.



P0002062

Start

When the DCU panel is started, the "Engine Data" menu is displayed; press "ESC" to come to the main menu.

- | | |
|---------------------------------|---|
| 1 LED display | 6 ON/OFF. Starts and stops the system |
| 2 START. Starts the engine | 7 Scroll downwards in menus |
| 3 SPEED -. Reduces engine rpm | 8 SEL. Selects in menus |
| 4 SPEED +. Increases engine rpm | 9 Scroll upwards in menus |
| 5 STOP. Stops the engine | 10 ESC. Return to previous menu selection |

| | |
|----------------------|-------------|
| ► Engine data | Trip Reset |
| Preheat | Setup |
| Governor mode | Information |
| Diagnostics | |

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| | | | |
|--------------------|-----|-----------|-----|
| ► Eng speed | rpm | Boost prs | kpa |
| Cool tamp | c | Boost tmp | C |
| Oil pres | kpa | Oil temp | C |
| Eng hours | h | Batt Volt | V |

P0002064

Menus

There are several sub-menus under each main menu. There is not space for all the menu choices on the display. To scroll through the menus, use the **7** and **9** buttons on the display. Press the **SEL** button **8** to make a selection. Refer to the illustration on the previous page.

NOTICE! The **Setup** menu can be used to select the language that you want to use on the display.

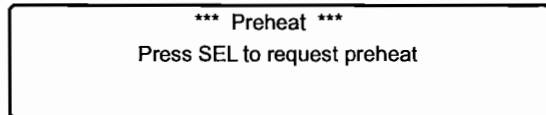
Main menu

- **Engine data**, current engine data
- **Preheat**, manual activation of pre-heating. Must be activated with temperatures below 0°C (32°F)
- **Governor mode**, activation of droop
- **Diagnostics**, shows fault codes as text
- **Trip reset**, resets trip data
- **Setup**, parameter setting
- **Information**, shows the currently applicable hard/software, data sets and engine identification for the engine and DCU data

Engine data

shows relevant engine data.

- Engine speed, can be controlled with the **SPEED+** and **SPEED-** buttons (rpm)
- Charge pressure (kPa)
- Coolant temperature (°C)
- Charge air temperature (°C)
- Oil pressure (kPa)
- Oil temperature (°C)
- Engine hours (h)
- Battery voltage (V)
- Fuel consumption (l/h)
- Instantaneous fuel consumption (trip fuel) (l)



P0002065

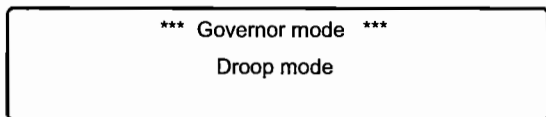
Preheat

manual activation of pre-heating. When it is activated, the EMS system senses at start-up if pre-heating is needed. For automatic pre-heating, refer to the *Setup / Preheat on ignition* menu.

NOTICE! Must be activated with temperatures below 0°C (32°F).

The pre-heating time is adjusted to suit the engine temperature, and can last for up to 50 seconds both before and after starting. Refer also to *Starting procedure EMS 2*.

- Press **SEL**, the text **Preheat requested** will be shown
- The display automatically returns to the **Engine Data** menu.

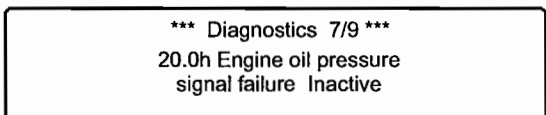


P0002066

Governor mode

activates/shuts off droop. To set the droop level, refer to the *Setup / Governor gradient or Governor droop* menu.

- Select **Isochronous mode** or **Droop mode** with the SEL button.

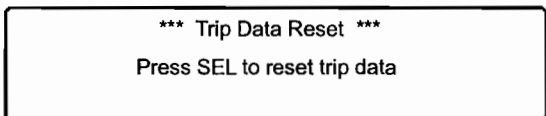


P0002067

Diagnostics

shows the error list containing the 10 latest active and inactive faults. The fault codes are shown as text on the display.

- Scroll through the fault list with the arrow keys.



P0002068

Trip Data reset

resets trip data, such as fuel consumption.

- Press the **SEL** button to reset trip data

| Setup | |
|---------------------|-------------|
| ► Set Application : | (Versatile) |
| Units : | (metric) |
| Language : | (English) |

P0002069

Setup

parameter setting in the engine's control systems. Different menus appear under **Customer parameter**, depending on whether **Versatile** or **Gen set** has been selected from **Set application**. See below.

The parameters that can be set/selected (choice is made with the SEL button) are:

- **Set application**, setting **Versatile** or **Gen set**. Depending on the selection made here, different menus will appear under **Customer parameter**.
- **Unit**, setting of units (metric or US imperial).
- **Language**, setting the language used on the display. Choose between English, French, German and Spanish.
- **Stop energized to**, setting of external stop input. Activated by **Stop** or **Run**.
Stop: The stop input must be connected to voltage to stop the engine.
Run: The stop input must be connected to voltage to run the engine.
- **Customer parameter**, setting alarm limits. Refer to *Customer parameter / Versatile* and *Customer parameter / Gen set*.
- **Throttle input setting**, setting of engine-speed control and voltage limits. Refer to *Throttle input setting*.
- **Display setting**, setting the display. refer to *Display setting*.

Customer parameter / Versatile

- **Idle engine speed** - setting idle speed.
- **Preheat on ignition** - activation of automatic pre-heating. The engine control system senses if pre-heating is needed and activates it directly at switch-on.
- **Governor gradient (Nm/rpm)** - setting of droop level, when activated. For activation, refer to *Governor droop* in the main menu.
- **Oil temp warning limit (°C)** - setting alarm limit for oil temperature.
- **Coolant temp warning limit (°C)** - setting alarm limit for coolant temperature.

| Set up (Versatile) | |
|-----------------------|-------|
| ► Idle engine speed : | rpm |
| Preheat on ignition : | |
| Governor gradient : | Nm/pm |

P0002070

| Set up (Gen set) | |
|--------------------------|--|
| ► Primary engine speed : | |
| Preheat on ignition : | |
| Governor droop : | |

P0002071

Customer parameter / Gen set

- **Primary engine speed** - selection of engine rpm, 1500 or 1800 rpm.
- **Preheat on ignition** - activation of automatic pre-heating. The engine control system senses if pre-heating is needed and activates it directly at switch-on.
- **Governor droop (%)** - setting of droop level, when activated. For activation, refer to "Governor droop" in the main menu.
- **Overspeed limit (%)** - setting of limit for overspeed alarm, % of set engine rpm.
- **Overspeed shutdown** - activation of engine shut-down with overspeed alarm. Refer to "Overspeed limit" to activate the alarm limit for the excess rpm alarm.
- **Oil temp warning limit (°C)** - setting alarm limit for oil temperature.
- **Coolant temp limit (°C)** - setting alarm limit for coolant temperature.

| Setup(Throttle) | |
|-----------------------------------|--|
| Setup throttle mode : *** OFF *** | |

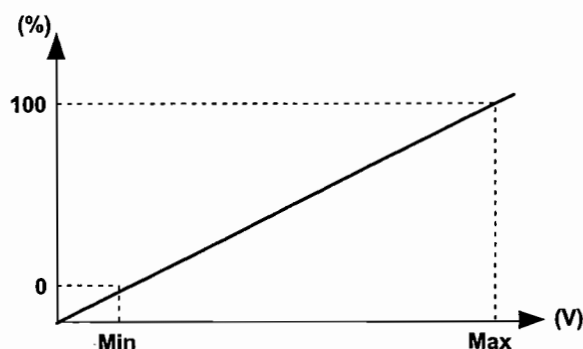
| Setup(Throttle) | |
|-----------------------|--|
| ► Set throttle mode : | |
| Set idle voltage : | |
| Set mx voltage : | |

P0002955

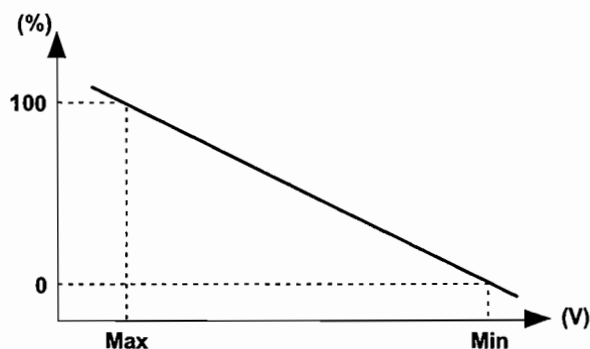
Throttle input setting

rpm control setting (throttle operation).

- **Set throttle mode** - OFF - engine rpm is controlled via the DCU panel.
ext throttle input - engine speed is controlled with a potentiometer (accelerator).
ext voltage input - engine rpm is controlled by an external unit.
- **Set idle voltage (V)** - idle voltage level setting.
- **Set max voltage (V)** - full throttle voltage level setting.



P0002074



| Setup(Display) | | |
|--------------------------|---|-------|
| ► Set contrast | : | 60% |
| Set backlighttime | : | 5 sec |
| Set backlight brightness | : | 10 |

P0002075

| *** Information *** | | |
|----------------------|---|--|
| ► Engine hardware Id | : | |
| Engine software Id | : | |
| Engine Dataset1 Id | : | |

P0002076

Display setting

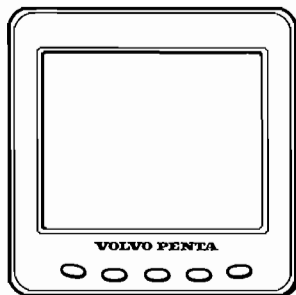
settings for the display. Adjustment is made with the 7 and 9 buttons; see DCU panel illustration.

- **Set contrast (%)** - contrast setting.
- **Set backlight time (sec)** - time setting (in seconds) for display backlighting on, lighting is then shut off if the panel is not used.
- **Set backlight brightness** - display backlighting brightness setting.

Information

shows the data for the engine and DCU.

- **Engine hardware Id** - engine control unit part number.
- **Engine software Id** - engine control unit software part number.
- **Engine dataset1 Id** - engine data set 1 part number.
- **Engine dataset2 Id** - engine data set 2 part number.
- **Vehicle Id** - chassis number.
- **DCU hardware Id** - DCU part number.
- **DCU software Id** - DCU software part number.
- **DCU dataset1 Id** - DCU data set 1 part number.
- **DCU dataset2 Id** - DCU data set 2 part number.



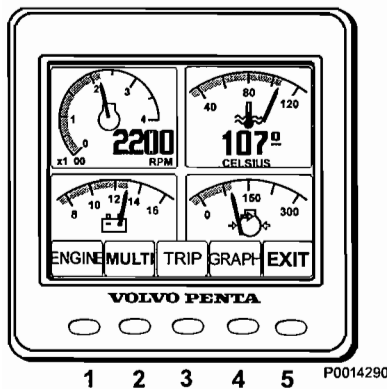
P0002061

DU (Display Unit)

The DU is an computerized instrument panel which shows engine working values on an LCD screen. In the display it is possible to show multiple windows with different information, i. g. engine rpm, coolant temperature, fuel consumption and fault messages.

At start up, the display performs a self-test. If a constant signal is heard, the system has discovered a malfunction. The display will work but may act in an unexpected way.

The DU is connected to the engine interface connector.

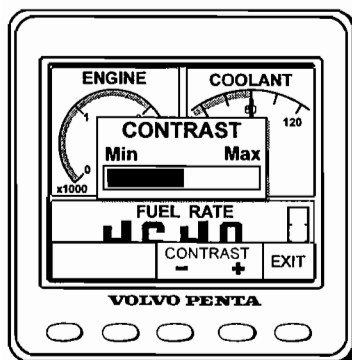


P0014290

Display modes

Press any of button 1–4 to view the function menu for the buttons, appearing in the lower part of the display. To leave the menu, wait a few seconds or press button 5 (EXIT).

- 1 Engine
- 2 Multi
- 3 Trip
- 4 Graph
- 5 Exit

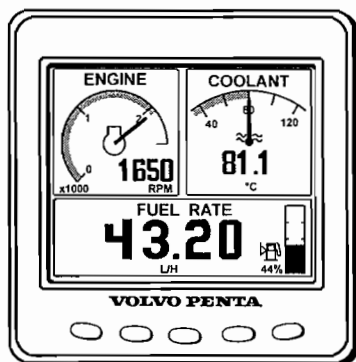


P0002403

Contrast

In the display modes Engine, Trip and Graph, it is possible to adjust the contrast.

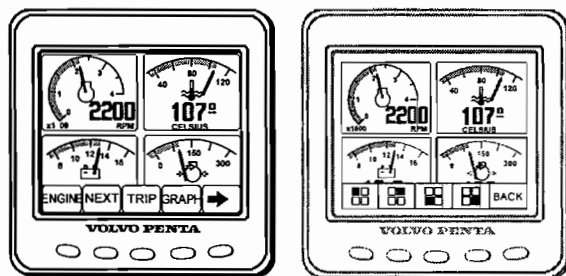
Press button 5 outside the menu and then + (button 4) or – (button 3) to adjust the contrast.



P0002413

Engine

Rpm and coolant temperature is shown in the upper part of the display. In the lower part it will show trip computer and a fuel level indicator, if these function are installed.

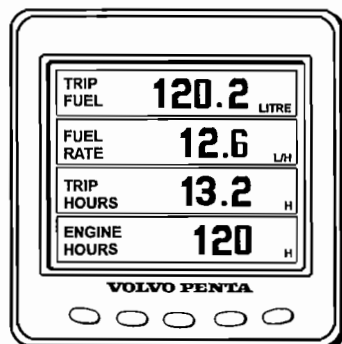


P0014208

Multi

In the multi mode, button 2, the information can be shown in four windows, analogue or digital. The display toggles between the two when button 2 is pressed repeatedly.

By pressing button 5, the right arrow, you choose what information to be shown in the different windows. Press repeatedly on the button that correspond to the window, until desired information is shown.



P0002418

Trip

To display the trip computer press button 3, Trip

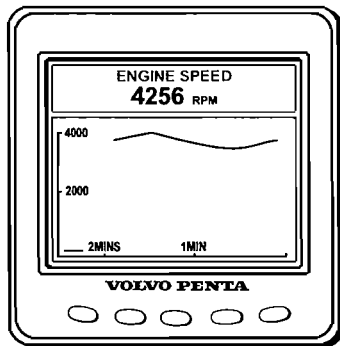
Trip Fuel, since last reset

Fuel Rate, fuel consumption

Trip hours, since last reset

Engine hours, total amount of operating hours

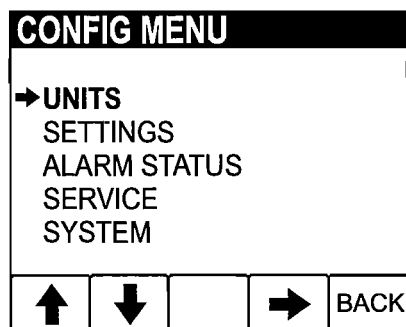
Reset by pressing button 3 for three seconds until a beep is heard.



P0014207

Graph

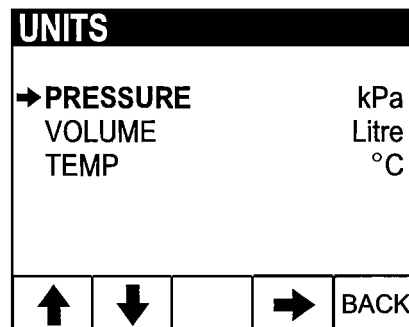
The information is shown as graphs. Press button 4 repeatedly to choose what information will be shown. The time interval is set in the Configuration menu. If the connection is broken there will be a straight line in the display.



P0014209

Configuration menu

Press button 5 for three seconds to enter the Configuration menu. Navigate with the up and down arrows, select with the right arrow.



P0014210

Units

- PRESSURE; kPa, PSI
- VOLUME; LITRE, GAL, Imperial GAL.
Fuel rate is adjusted according to volume unit, L/H, GAL/H, IGAL/H.
- TEMPERATURE; °C, °F

| | | | | |
|--|---|--|---|------|
| TOTAL ALARMS = 12 | | | | |
| 12. STARTER MOTOR CONTROL FAILURE ENGINE HRS= 0 | | | | |
| 11. SUPER CHARGER CONTROL FAILURE ENGINE HRS= 0 | | | | |
| ↑ | ↓ | | → | EXIT |

P0014212

| SETTINGS | | | | |
|------------|---|---------|---|------|
| → LANGUAGE | | ENGLISH | | |
| BLEEP | | OFF | | |
| DISPLAY | | | | |
| ↑ | ↓ | | → | BACK |

P0014211

| SYSTEM | | | | |
|------------------|---|----|---|------|
| → DEMO | | ON | | |
| RESTORE DEAFULTS | | | | |
| COM VIEWER | | | | |
| PROG. TX | | | | |
| ABOUT | | | | |
| ↑ | ↓ | | → | BACK |

P0014213

Alarm Status

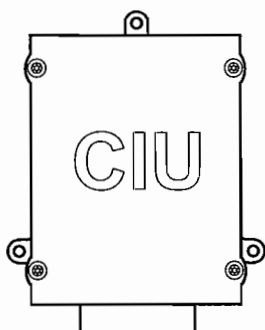
List of active alarms, refer to *Fault Handling* page 33

Settings

- LANGUAGE; setting of what language is to be used in the display.
- BLEEP; On/Off, setting if pressing the instrument buttons will be followed by a beep or not.
- DISPLAY; setting of ENGINE RPM gauges
RPM ENGINE, 2500–9000 RPM, in steps of 500 RPM
GRAPH RANGE, 2 minutes– 8 hours in the following steps,
2MINS, 10MINS, 30MINS, 60MINS, 2HRS, 4HRS, 8HRS

SYSTEM

- DEMO, switches the DEMO mode ON/OFF.
- RESTORE DEAFULTS, reset all configuration to default values.
- COM VIEWER, displays latest message on communication ports
- PROG TX, transfers content of the application on Flash memory to other CAN units on the same CAN bus.
- ABOUT, displays
ID NO – display serial number
EEPROM – number of write on EEPROM
VERS – software version number
CHK – Flash memory checksum
PART No – Volvo software part number
SOURCE – source of received data
LABEL – Allocated Label on the same bus.



P0002060

CIU (Control Interface Unit)

The CIU is a "translator" between the control unit (EMS) and the customer's own control panel. The CIU has two serial communication links, one fast and one slow.

The fast one is a so-called CAN link. All data related to instruments, indication lamps, connectors and potentiometers is controlled by this link.

The slow link manages diagnostic information for flashing codes etc.

Easy Link Instruments

The following Easy Link instruments are available:

- Tachometer / hours counter (fault codes are also displayed on the tachometer display when the diagnostic button is pressed)
- Coolant temperature
- Oil pressure
- Oil temperature
- Battery voltage
- Alarm panel
- Turbo pressure

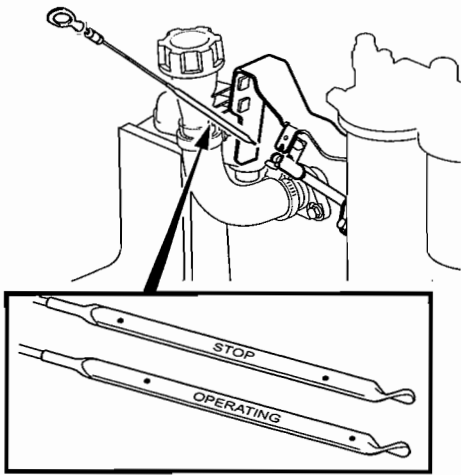
Starting

Make it a habit of giving the engine and engine room a visual check before starting. This will help you to discover quickly if anything abnormal has happened, or is about to happen.

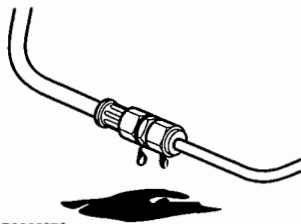
Also check that instruments and warning displays show normal values after you have started the engine.

WARNING!

Never use start spray or similar products as starting aid. Explosion risk!



P0004311



P0002078

Before Starting

- Check that the oil level is between the MIN and MAX marks.

NOTICE! The oil level can be read both when the engine is stopped (the STOP side of the dipstick) and with the engine running (the OPERATING side of the dipstick).

For filling refer to *Oil level, checking and topping up*.

- Open the fuel valves.
- Check the fuel pre-filter; refer to *Draining condensate, fuel system* page 57.
- Check the coolant level and that the radiator is not blocked externally. Refer to *Coolant Level, Checking and Topping Up* page 60 and *Charge Air Cooler, External Cleaning* page 61

WARNING!

Do not open the coolant filler cap when the engine is warm, except in emergencies, this could cause serious personal injury. Steam or hot fluid could spray out.

- Check that no leakage of oil, fuel or coolant is present.
- Turn the main switch(es) on.
- Move the engine speed control to idle, and open the disengageable clutch/gearbox if installed.

IMPORTANT!

Never break the circuit with the main switch while the engine is running, as this may damage the alternator.

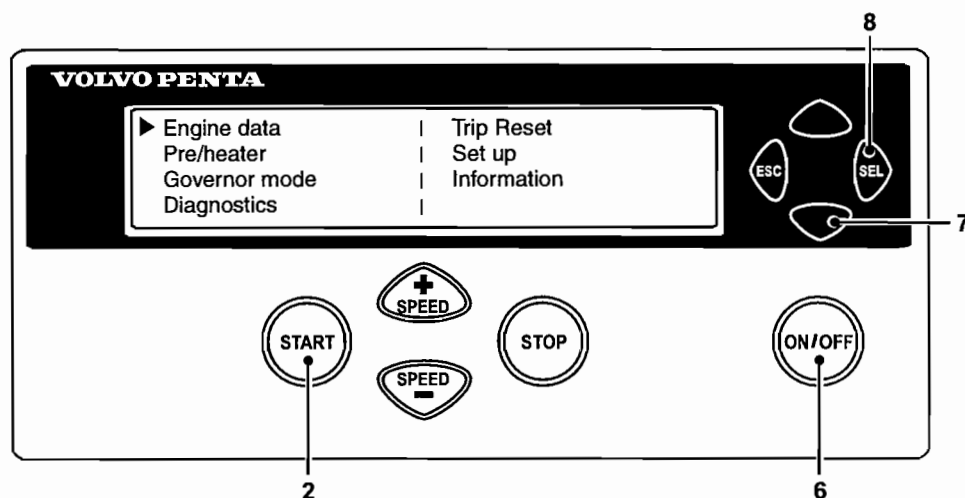
Starting the Engine

EMS (Engine Management System)

The pre-heating time is adjusted to suit the engine temperature, and can last for up to 50 seconds both before and after starting.

The starter motor connection time is maximized to 20 seconds. After that, the starter motor circuit is cut for 80 seconds to protect the starter motor against overheating.

DCU (Display Control Unit)



P0002079

With pre-heating

- 1 Depress the **ON/OFF**-button (6).
- 2 Press the **SEL** button (8) to come to the main-menu.
- 3 Scroll down to **Pre/heater** with scroll button (7), press **SEL**-button (8)
- 4 In the **pre-heater** menu, press the **SEL**-button (8) to select pre-heating.
- 5 Press the **START**- button (2).

Without pre-heating

- 1 Depress the **ON/OFF**-button (6).
- 2 Press the **START**-button (2).

Leave the engine to idle for the first 10 seconds. Then warm the engine up at low speed and under low load. Never race the engine when it is cold.

Starting in Extreme Cold

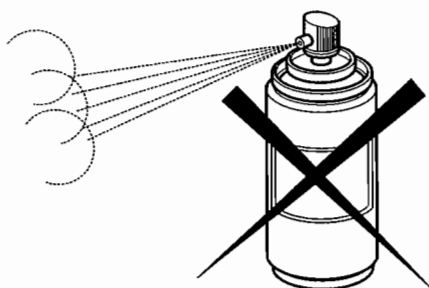
Certain preparations must be made to facilitate engine starting, and in some cases to make starting possible at all:

- Use a winter grade fuel (of a well-known make) which has been approved for the relevant temperature. This reduces the risk of wax deposits in the fuel system. At extremely low temperatures, the use of a fuel heater is recommended.
- For fully acceptable lubrication, a synthetic engine oil of recommended viscosity for the relevant temperature should be used. Please refer to the *Maintenance, lubrication system* chapter. Synthetic lubricants are able to manage a wider temperature range than mineral-based lubricants.
- Pre-heat the coolant with a separately installed electric engine heater. In extreme cases, a diesel-burning engine heater may be needed. Ask your Volvo Penta dealer for advice.
- Make sure that the cooling system is filled with a glycol mixture. Please refer to the *Maintenance, cooling system* chapter.
- The batteries should be in good condition. Cold weather reduces battery capacity. Increased battery capacity may be necessary.

Never Use Start Spray

WARNING!

Never use start spray or similar products as starting aid. Explosion risk!



P0002080

Starting Using Auxiliary Batteries

WARNING!

Explosion hazard. Batteries contain and give off an explosive gas which is highly flammable and explosive. A short circuit, open flame or spark could cause a violent explosion. Ventilate well.

- 1 Check that the auxiliary batteries are connected (series or parallel) so that the rated voltage corresponds to the engine system voltage.
- 2 First connect the red (+) jumper cable to the auxiliary battery, then to the flat battery. Then connect the black (-) jumper cable to the auxiliary battery and to a location that is **somewhere away from the discharged battery**, e.g. the main switch negative terminal or the negative terminal on the starter motor.
- 3 Start the engine.

WARNING!

Do not touch the connections during the start attempt: Risk of arcing.

Do not bend over any of the batteries either.

- 4 Remove the cables in the reverse order.

IMPORTANT!

The ordinary cables to the standard batteries must not be loosened on any condition.

Operation

Correct operating technique is very important for both fuel economy and engine life. Always let the engine warm up to normal operating temperature before operating at full power. Avoid sudden throttle openings and operation at high engine rpm.

Reading the Instruments

Check all instruments directly after starting, and then regularly during operation.

NOTICE! On engines in continuous operation, the lubrication oil level must be checked at least every 24 hours. Refer to *Oil level, checking and topping up*.

Alarms

If the EMS 2 system receives abnormal signals from the engine, the control unit generates fault codes and alarms, in the form of lamps and audible warnings. This is done by means of CAN signals to the instrument.

More information about fault codes and fault tracing can be found in the chapter. *Fault Code Register* page 36.

Maneuvering

Operation at low load

Avoid long-term operation at idle or at low load, since this can lead to increased oil consumption and eventually to oil leakage from the exhaust manifold, since oil will seep past the turbocharger seals and accompany the induction air into the inlet manifold at low turbo pressure.

One consequence of this is carbon build-up on valves, piston crowns, exhaust ports and the exhaust turbine.

At low loads, the combustion temperature may become so low that complete combustion cannot be ensured, resulting in possible fuel dilution of lubricating oil and eventually leakage from the exhaust manifold.

If the following points are done as a complement to normal maintenance, there will be no risk of malfunctions caused by operation at low load.

- Reduce operation at low load to a minimum. If the engine is regularly test-run without load once a week, the duration of this operation should be limited to 5 minutes.
- Run the engine at full load for about 4 hours once a year. In this way carbon deposits in the engine and exhaust system are given the chance to burn up.

Engine Shutdown

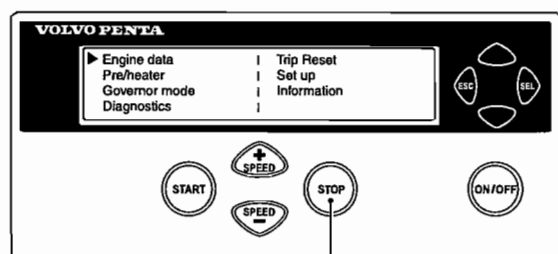
During longer breaks in operation, the engine must be warmed up at least once every two weeks. This prevents corrosion in the engine. If you expect the engine to remain unused for two months or more, it must be laid up: Refer to the chapter *Storage* page 68.

Before Engine Shutdown

Let the engine run for a few minutes without loading before stopping it. This allows engine temperature equalization and prevents boiling once stopped and also allows the turbocharger to cool down. This contributes to long service life without malfunctions.

Stop the Engine

- Disengage the clutch (if possible).
- Depress the **STOP**-button (5).



P0002081



P0002078

After Engine Shutdown

- 1 Check the engine and engine bay for leakage.
- 2 Turn off the main switches before any long stoppage.
- 3 Carry out maintenance in accordance with the schedule.

For longer breaks in operation

During longer breaks in operation, the engine must be warmed up at least once every two weeks. This prevents corrosion attacks in the engine.

If you expect the engine to be unused for two months or more, it must be laid up. Refer to the chapter *Short Term Storage*.

NOTICE! If there is a risk of frost, the coolant in the cooling system must have sufficient frost protection. Refer to the chapter *Maintenance* page 58.

A poorly-charged battery can freeze and burst; refer to *Battery, Charging* page 66.



P0003479

Extra Stop

For location of the extra stop, please refer to *Location of Sensors* page 49.

WARNING!

Working with or going close to a running engine is a safety risk. Watch out for rotating components and hot surfaces.

Fault Handling

Fault Tracing

A number of symptoms and possible causes of engine malfunctions are described in the table below. Always contact your Volvo Penta dealer if any problems occur which you cannot solve by yourself.

IMPORTANT!

Read through the instructions for care and maintenance in the *Safety precautions for boat operation* chapter before starting work.

| Symptoms and possible causes | |
|--|-------------------------------------|
| The diagnostics button indicator blinks | Refer to <i>Diagnostic Function</i> |
| Engine cannot be stopped | 2, 5 |
| Starter motor does not rotate | 1, 2, 3, 4, 5, 6, 7, 24 |
| Starter motor rotates slowly | 1, 2 |
| Starter motor rotates normally but engine does not start | 8, 9, 10, 11, |
| Engine starts but stops again | 8, 9, 10, 11, 13 |
| Engine does not reach correct operating speed at full throttle | 9, 10, 11, 12, 13, 21, 25, 26 |
| Engine runs unevenly | 10, 11 |
| High fuel consumption | 12, 13, 15, 25 |
| Black exhaust smoke | 12, 13 |
| Blue or white exhaust smoke | 14, 15, 22 |
| Lubricating oil pressure too low | 16 |
| Coolant temperature too high | 17, 18, 19, 20 |
| Coolant temperature too low | 20 |
| No charge, or poor charge | 2, 23 |

- 1 Discharged batteries
- 2 Poor contact/open circuit in cables
- 3 Main switch in off position
- 4 Main fuse blown
- 5 Faulty ignition switch
- 6 Faulty main relay
- 7 Faulty starter motor/solenoid
- 8 Lack of fuel:
 - fuel taps closed
 - fuel tank empty/wrong tank connected
- 9 Blocked fuel filter/primary filter (because of contamination, or paraffin fraction separation in fuel at low temperature)
- 10 Air in the fuel system
- 11 Water or contaminants in fuel
- 12 Faulty unit injector
- 13 Insufficient air supply to engine:
 - blocked air filter
 - air leakage between turbocharger and engine inlet manifold
 - fouled compressor section in turbocharger
 - faulty turbocharger
 - poor engine bay ventilation
- 14 Coolant temperature too high
- 15 Coolant temperature too low
- 16 Oil level too low
- 17 Coolant level too low
- 18 Air in the coolant system
- 19 Faulty circulation pump
- 20 Defective thermostat
- 21 Clogged charge air cooler
- 22 Oil level too high
- 23 Alternator drive belt slipping
- 24 Water entry into engine
- 25 High back pressure in exhaust system
- 26 Break in Pot+ cable to pedal

Diagnostic Function

The diagnostic function monitors and controls the engine. The diagnostic function has the following tasks:

- detecting and locating disturbances
- reporting detection of disturbances
- providing guidance when fault tracing

A fault message in the form of a fault code is always generated when a disturbance is detected by the diagnostic function. If the diagnostic function detects a disturbance in the system, this is reported with a fault code via the instruments.

The diagnostic function protects the engine and ensure continued operation by affecting the engine, depending on the severity the engine is affected differently.

Depending on what instrumentation that is being used the fault message is shown in various ways (fault codes can also be read out by VODIA).

All fault codes and fault messages can be found in the Fault Code Register together with information about cause, reaction and actions, for further information see chapter *Fault Code Register*.

CIU (Control Interface Unit)

When the system detects a malfunction, the diagnostics lamp flashes. If the diagnostics button is pressed and then released, a fault code is flashed out.

The fault code consists of two groups of flashes, separated by a pause of two seconds. A fault code is obtained by counting the number of flashes in each group.

Example

⚡ ⚡ pause ⚡⚡⚡⚡ = fault code 2.4

The fault code is stored and can be read off as long as the malfunction remains. Information about causes, effects and actions required is available in the Fault Code chapter.

Do as follows to read off the fault code:

- 1 Press the diagnostics button.
- 2 Release the diagnostics button and note down the fault that is flashed out.
- 3 Repeat items 1–2. A new fault code will be flashed out if more faults are stored. Repeat until the first fault code reappears.

NOTICE! When the first fault code reappears, all fault codes have been read off.

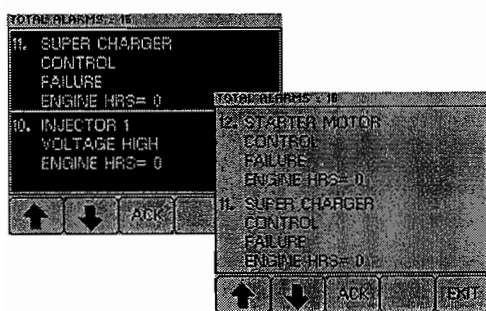
If the diagnostics button is pressed after the fault has been rectified and the fault codes have been erased, code 1.1 "No fault" will be displayed.

DU (Display Unit)

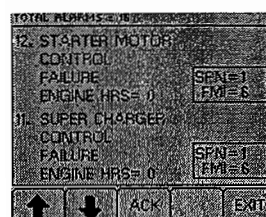
- 1 When the system detects a fault, a pop-up is shown on the display. Depending on the severity of the fault the following text will appear **ALARM STOP / PRESS ANY KEY** or **WARNING! / PRESS ANY KEY**; a buzzer will sound.
- 2 Reduce engine speed to idle or shut down the engine.



P0014030



P0014029



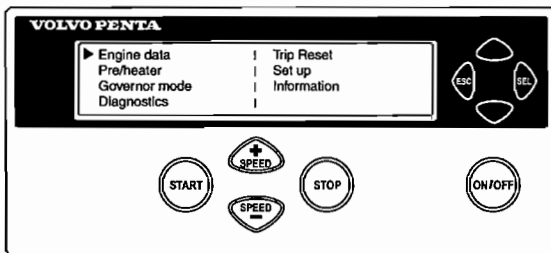
P0014038

- 3 Press the SEL button to get to the fault list. The fault list shows fault messages and the number of hours of operation when the fault occurred.
- 4 Press **ACK** to acknowledge the fault code. The display background changes color (and the buzzer stops). The fault must be acknowledged before it can disappear from the fault list.
- 5 Look up the fault code in the *Fault Code Register* and take the necessary actions.
- 6 Press button 4 for at least three seconds to view SPN and FMI codes.
- 7 Press **EXIT** to leave the fault list. Alarms that are acknowledged and rectified are automatically erased from the list.

| | | | | |
|----------------------|---------|-----------|-------|---|
| Eng speed | 700 rpm | Boost prs | 4 kpa | ▲ |
| Cool Temp | 90 °C | Boost tmp | 59 °C | |
| Oil Pres | 480 kpa | Oil Temp | 87 °C | |
| !! ENGINE WARNING !! | | | | ▼ |

| | | | | |
|---------------------------|---------|-----------|-------|---|
| Eng speed | 700 rpm | Boost prs | 4 kpa | ▲ |
| Cool Temp | 90 °C | Boost tmp | 59 °C | |
| Oil Pres | 480 kpa | Oil Temp | 87 °C | |
| Press SEL for information | | | | ▼ |

P0014037



P0014039

Display Control unit (DCU)

- 1 When a fault is detected the following text is displayed:
!! ENGINE WARNING !! alternating with
Press SEL for information.
- 2 Reduce engine speed to idle or shut down the engine.
- 3 Press the **SEL** button to get to the fault list.
The fault list shows:
 - hours of operation
 - fault messages
 - active/non-active faults
- 4 Look up the fault code in the *Fault Code Register* and take the necessary actions.
- 5 Press **ESC** to leave the fault list.

NOTICE! To get to the fault list when no fault codes are set, press the **SEL** button and select **Diagnostics** from the menu.

Easy Link Instruments

- 1 When the system detects a fault the diagnostics lamp flashes.
- 2 Press the diagnostics button. The fault code is shown as text in the tachometer display.
- 3 Look up the fault code in the *Fault Code Register* and take the necessary actions.
- 4 When the fault has been rectified, the fault code disappears from the display and the diagnostics lamp goes out.

If the diagnostics lamp is pressed after the fault has been rectified and the fault code erased, the code **1.1**, **No fault** will be displayed.

Erasing fault codes

The memory of the diagnostic function is reset when the power to the engine is disconnected.

When the power is switched on again the diagnostic function will check if there are any malfunctions in the system. If so a new fault codes is registered.

NOTICE! Power must be disconnected completely.

This means that fault that hasn't been corrected:

- 1 are shown as active, the active fault code can then be erased with the VODIA tool.
- 2 must be acknowledge and read out every time the engine is switched on.

If the diagnostic button is depressed after the fault has been corrected and fault code deleted, the code **1.1, No fault**, will show.

Fault Code Register

No fault (Code 1.1)

| Cause | Reaction | Remedy |
|-----------------------------|----------|--------|
| There are no active faults. | | |

Preheating Relay (Code 5.4, PID 45/SPN 626)

| Cause | Reaction | Remedy |
|---|---|---|
| <ul style="list-style-type: none"> Short circuit to positive (+) or earth (ground) (-). Open circuit. | <ul style="list-style-type: none"> Preheating can not be activated. Preheating is constantly connected. | <ul style="list-style-type: none"> Check that the relay input cable is not damaged. Check relay function. |

Fuel Pressure Sensor (Code 3.6, PID/SPN 94)

| Cause | Reaction | Remedy |
|---|--|---|
| <ul style="list-style-type: none"> Short circuit to positive (+) or earth (ground) (-). Open circuit. | <ul style="list-style-type: none"> None | <ul style="list-style-type: none"> Check that the fuel pressure sensor connector is correctly installed. Check that the fuel pressure sensor cable is not damaged. Check that the fuel pressure sensor is correctly installed. Check fuel pressure sensor function. |

Fuel Pressure (Code 3.8, PID/SPN 94)

| Cause | Reaction | Remedy |
|---|--|---|
| <ul style="list-style-type: none"> Low supply pressure | <ul style="list-style-type: none"> None | <ul style="list-style-type: none"> Check if it is possible to build up pressure with the hand pump Check the fuel filter Check the fuel pre-filter |

Water in Fuel (Code 2.1, PID/SPN 97)

| Cause | Reaction | Remedy |
|---|--|---|
| <ul style="list-style-type: none"> Water in fuel | <ul style="list-style-type: none"> None | <ul style="list-style-type: none"> Empty the primary fuel filter |

Indicator for Water in Fuel (Code 2.9, PID/SPN 97)

| Cause | Reaction | Remedy |
|---|--|---|
| <ul style="list-style-type: none"> Short circuit Open circuit Fault in indicator | <ul style="list-style-type: none"> None | <ul style="list-style-type: none"> Check the indicator cables for breaks and short circuits Check indicator function. Change indicator as necessary |

Oil Level (Code 5.7, PID/SPN 98)

| Cause | Reaction | Remedy |
|--|--|---|
| <ul style="list-style-type: none"> Oil level to low | <ul style="list-style-type: none"> None | <ul style="list-style-type: none"> Check the oil level |

Oil Level Sensor (Code 5.9, PID/SPN 98)

| Cause | Reaction | Remedy |
|---|--|--|
| <ul style="list-style-type: none"> Shorted to plus (+) or minus (-) Break | <ul style="list-style-type: none"> None | <ul style="list-style-type: none"> Check that the cable harness to the oil level sensor has not been damaged Check the oil level sensor function |

Oil Pressure Sensor (Code 3.1, PID/SPN 100)

| Cause | Reaction | Remedy |
|---|--|--|
| <ul style="list-style-type: none"> Short circuit to positive (+) or earth (ground) (-) Open circuit | <ul style="list-style-type: none"> None | <ul style="list-style-type: none"> Check that the oil pressure sensor cable is not damaged Check that the oil pressure sensor is correctly connected |

Oil Pressure (Code 6.6, PID/SPN 100)

| Cause | Reaction | Remedy |
|---|---|---|
| <ul style="list-style-type: none"> Oil pressure is too low | <ul style="list-style-type: none"> Engine control module reduces engine power (unless the protection has been shut off with the VODIA diagnostic tool) | <ul style="list-style-type: none"> Check oil level Check that the air filter is not blocked Check system pressure valves and safety valves in the oil system Check oil pressure sensor function |

Boost Temperature Sensor (Code 3.2, PID/SPN 105)

| Cause | Reaction | Remedy |
|---|--|---|
| <ul style="list-style-type: none"> Short circuit to positive (+) or earth (ground) (-) Open circuit | <ul style="list-style-type: none"> None | <ul style="list-style-type: none"> Check that the boost temperature sensor connector is correctly installed Check that the boost temperature sensor cable is not damaged Check that the boost temperature sensor is correctly installed Check boost temperature sensor function |

Boost Temperature (Code 6.2, PID/SPN 105)

| Cause | Reaction | Remedy |
|---|---|---|
| <ul style="list-style-type: none"> Boost temperature is too high | <ul style="list-style-type: none"> Engine control module reduces engine power (unless the protection has been shut off with the VODIA diagnostic tool) | <ul style="list-style-type: none"> Check the coolant level Check the charge air cooler (cleanliness) Check boost temperature sensor function Check the function of the thermostat |

Boost Pressure Sensor (Code 3.4, PID/SPN 102/106)

| Cause | Reaction | Remedy |
|---|--|---|
| <ul style="list-style-type: none"> Short circuit to positive (+) or earth (ground) (-) Open circuit | <ul style="list-style-type: none"> Engine smokes more than normally during acceleration/load increase | <ul style="list-style-type: none"> Check that the boost pressure sensor connector is correctly installed Check that the boost pressure sensor cable is not damaged Check that the boost pressure sensor is correctly installed Check boost pressure sensor function |

Boost Pressure Sensor (Code 3.5, PID/SPN 106)

| Cause | Reaction | Action |
|--|--|--|
| <ul style="list-style-type: none"> High charge pressure | <ul style="list-style-type: none"> Engine power is reduced or engine stops. | <ul style="list-style-type: none"> Check that the charge air pressure sensor connector is correctly installed Check that the charge air pressure sensor cable is not damaged Check that the charge air pressure sensor is correctly installed Check charge air temperature sensor function |

Coolant Temperature Sensor (Code 3.3, PID/SPN 110)

| Cause | Reaction | Remedy |
|---|---|---|
| <ul style="list-style-type: none"> Short circuit to positive (+) or earth (ground) (-) Open circuit | <ul style="list-style-type: none"> Preheating is also activated when the engine is hot | <ul style="list-style-type: none"> Check that the coolant temperature sensor connector is correctly installed Check that the coolant temperature sensor cable is not damaged Check that the coolant temperature sensor is correctly installed Check coolant temperature sensor function |

Coolant Temperature (Code 6.1, PID/SPN 110)

| Cause | Reaction | Remedy |
|---|---|---|
| <ul style="list-style-type: none"> Coolant temperature is too high | <ul style="list-style-type: none"> Engine control module reduces engine power (unless the protection has been shut off with the VODIA diagnostic tool) | <ul style="list-style-type: none"> Check the coolant level Check the charge air cooler (cleanliness) Check if there is air in the cooling system Check the pressure cap on the expansion tank Check coolant temperature sensor function Check thermostat function |

Coolant Level (Code 2.2, PID/SPN 111)

| Cause | Reaction | Remedy |
|---|---|---|
| <ul style="list-style-type: none"> Low coolant level | <ul style="list-style-type: none"> Engine control module reduces engine power (unless the protection has been shut off with the VODIA diagnostic tool) | <ul style="list-style-type: none"> Check the coolant level Check coolant level monitor function |

Coolant Level Sensor (Code 2.3, PID/SPN 111)

| Cause | Reaction | Remedy |
|--|--|---|
| <ul style="list-style-type: none"> Short circuit to positive (+) Fault in sensor | <ul style="list-style-type: none"> None | <ul style="list-style-type: none"> Check that the coolant level sensor cable is not damaged Check coolant level sensor function |

TAD950VE, TAD951VE, TAD952VE

Crankcase Ventilation Pressure (Code 7.7, PID/SPN 153)

| Cause | Reaction | Remedy |
|---|---|--|
| <ul style="list-style-type: none"> Crankcase ventilation pressure too high | <ul style="list-style-type: none"> The engine is shut down (if the protection has not been shut off by the parameter tool) | <ul style="list-style-type: none"> Check whether the crankcase ventilation is blocked Check whether cylinder liners, pistons or piston rings are worn or damaged |

TAD950VE, TAD951VE, TAD952VE

Crankcase Ventilation Pressure Sensor (Code 7.8, PID/SPN 153)

| Cause | Reaction | Remedy |
|---|--|--|
| <ul style="list-style-type: none"> Shorted to plus (+) or minus (-) Break | <ul style="list-style-type: none"> None | <ul style="list-style-type: none"> Check that the crankcase ventilation pressure sensor contact is correctly installed Check that the cable harness to the crankcase ventilation pressure sensor has not been damaged Check that the crankcase ventilation pressure sensor is correctly installed Check crankcase ventilation pressure sensor function |

Battery Voltage, EMS (Code 3.9, PID/SPN 158)

| Cause | Reaction | Remedy |
|---|--|--|
| <ul style="list-style-type: none"> Faulty alternator Faulty battery, battery cables | <ul style="list-style-type: none"> None | <ul style="list-style-type: none"> Check the supply voltage from the control unit |

Battery Voltage, CIU (Code 6.9, PID/SPN 158)

| Cause | Reaction | Remedy |
|--|---|--|
| <ul style="list-style-type: none"> • Short circuit to negative (-) • Faulty alternator • Faulty battery, battery cables | <ul style="list-style-type: none"> • Problems in engine starting | <ul style="list-style-type: none"> • Check the supply voltage from the control unit • Check the batteries • Check the alternator • Check the 8-pin contact |

Oil Temperature Sensor (Code 3.7, PID/SPN 175)

| Cause | Reaction | Remedy |
|---|--|---|
| <ul style="list-style-type: none"> • Shorted to plus (+) or minus (-) • Break | <ul style="list-style-type: none"> • None | <ul style="list-style-type: none"> • Check that the cable harness to the oil temperature sensor has not been damaged • Check that the oil temperature sensor has been connected correctly |

Oil Temperature (Code 5.8, PID/SPN 175)

| Cause | Reaction | Remedy |
|---|--|---|
| <ul style="list-style-type: none"> • Oil temperature is too high | <ul style="list-style-type: none"> • The engine control module limits engine output(unless protection has been turned off with thediagnosis tool VODIA) | <ul style="list-style-type: none"> • Check the oil level • Check the oil temperature • Check the oil temperature sensor function |

Engine Speed (Code 2.6, PID/SPN 190)

| Cause | Reaction | Remedy |
|---|--|--|
| <ul style="list-style-type: none"> • Engine speed too high | <ul style="list-style-type: none"> • None | <ul style="list-style-type: none"> • After the engine has stopped, look for the reason for the high speed |

Starter Input CIU (Code 5.2, PPID 4/SPN 520194)

| Cause | Reaction | Remedy |
|--|--|---|
| <ul style="list-style-type: none"> • Shorted to minus (-) • Activated for too long | <ul style="list-style-type: none"> • The engine cannot be started • The engine starts immediately when ignition is turned on | <ul style="list-style-type: none"> • Check that connections to the ignition key/start panel have not been damaged • Check that the cable harness to the ignition key/start panel has not been damaged |

Stop Input CIU (Code 5.3, PPID 6/SPN 52095)

| Cause | Reaction | Remedy |
|--|--|--|
| <ul style="list-style-type: none"> • Short circuit to negative (-) • Open circuit • Activated for too long time | <ul style="list-style-type: none"> • Engine can only be stopped with the auxiliary stop (AUX STOP) on engine • Engine stops. A fault code is displayed for 40 seconds and the engine can not be started during this time. When a fault code is active, the engine can be started but not stopped | <ul style="list-style-type: none"> • Check that the starter switch connections are not damaged • Check that the ignition switch cable is not damaged |

Stop Input EMS (Code 4.8, PPID 6/SPN 970)

| Cause | Reaction | Remedy |
|---|--|---|
| <ul style="list-style-type: none"> • Short circuit to negative (-) • Open circuit | <ul style="list-style-type: none"> • Engine can only be stopped with the auxiliary stop | <ul style="list-style-type: none"> • Check that the starter switch connections are not damaged |

Start output/Start motor relay (Code 4.6, PPID 3/ SPN 677)

| Cause | Reaction | Remedy |
|--|--|---|
| <ul style="list-style-type: none"> • Shorted to plus (+) or minus (-) • Activated for too long | <ul style="list-style-type: none"> • The engine cannot be started • The engine starts immediately when ignition is turned on | <ul style="list-style-type: none"> • Check that connections to the ignition key/start panel have not been damaged • Check that the cable harness to the ignition key/start panel has not been damaged |

Piston Cooling Pressure (Code 6.7, PPID 8/SPN 520192)

| Cause | Reaction | Remedy |
|--|--|--|
| <ul style="list-style-type: none"> • Piston cooling pressure is too low | <ul style="list-style-type: none"> • Engine stopped | <ul style="list-style-type: none"> • Check that the oil pressure in the engine exceeds 175 kPa (25.4 psi) |

Piston Cooling Pressure Sensor (Code 6.8, PPID 8/SPN 520192)

| Cause | Reaction | Remedy |
|---|--|---|
| <ul style="list-style-type: none"> • Shorted to plus (+) or minus (-) • Break | <ul style="list-style-type: none"> • None | <ul style="list-style-type: none"> • Check that the piston cooling pressure sensor contact is correctly installed • Check that the cable harness to the piston cooling pressure sensor has not been damaged • Check the piston cooling pressure sensor functionality |

TAD950VE, TAD951VE, TAD952VE

Internal EGR (Code 8.5, PPID 19/SPN 2791)

| Cause | Reaction | Remedy |
|--|--|--|
| <ul style="list-style-type: none"> • Fault in cable harness (boost pressure sensor) • Mechanical fault on the IEGR | <ul style="list-style-type: none"> • Engine control module reduces engine power | <ul style="list-style-type: none"> • Check cable harness (boost pressure sensor) • Check the IEGR • Contact a Volvo Penta authorized workshop |

Speed Potentiometer Connected to CIU (Code 2.8, PPID 132/SPN 91, 608)

| Cause | Reaction | Remedy |
|---|--|---|
| <ul style="list-style-type: none"> • Shorted to plus (+) or minus (-) • Fault in sensor | <ul style="list-style-type: none"> • Engine goes to idle • Speed freezes | <ul style="list-style-type: none"> • Check that the potentiometer has been connected correctly • Check that the cable harness to the potentiometer has not been damaged • Check the potentiometer function |

Injector, Cylinder #1 (Code 7.1, SID 1/SPN 651)

| Cause | Reaction | Remedy |
|---|---|---|
| <ul style="list-style-type: none">• Electrical fault• Faulty compression or injector | <ul style="list-style-type: none">• Engine runs on 5 cylinders• Abnormal sound• Reduced performance | <ul style="list-style-type: none">• Check that the injector cables are not damaged• Check that the injector connections are not damaged• Check fuel supply pressure• Check the valve clearance• Do a compression test and check cylinder #1 |

Injector, Cylinder #2 (Code 7.2, SID 2/SPN 652)

| Cause | Reaction | Remedy |
|---|---|---|
| <ul style="list-style-type: none">• Electrical fault• Faulty compression or injector | <ul style="list-style-type: none">• Engine runs on 5 cylinders• Abnormal sound• Reduced performance | <ul style="list-style-type: none">• Check that the injector cables are not damaged• Check that the injector connections are not damaged• Check fuel supply pressure• Check the valve clearance• Do a compression test and check cylinder #2 |

Injector, Cylinder #3 (Code 7.3, SID 3/SPN 653)

| Cause | Reaction | Remedy |
|---|---|---|
| <ul style="list-style-type: none">• Electrical fault• Faulty compression or injector | <ul style="list-style-type: none">• Engine runs on 5 cylinders• Abnormal sound• Reduced performance | <ul style="list-style-type: none">• Check that the injector cables are not damaged• Check that the injector connections are not damaged• Check fuel supply pressure• Check the valve clearance• Do a compression test and check cylinder #3 |

Injector, Cylinder #4 (Code 7.4, SID 4/SPN 654)

| Cause | Reaction | Remedy |
|---|---|---|
| <ul style="list-style-type: none">• Electrical fault• Faulty compression or injector | <ul style="list-style-type: none">• Engine runs on 5 cylinders• Abnormal sound• Reduced performance | <ul style="list-style-type: none">• Check that the injector cables are not damaged• Check that the injector connections are not damaged• Check fuel supply pressure• Check the valve clearance• Do a compression test and check cylinder #4 |

Injector, Cylinder #5 (Code 7.5, SID 5/SPN 655)

| Cause | Reaction | Remedy |
|--|---|---|
| <ul style="list-style-type: none"> • Electrical fault • Faulty compression or injector | <ul style="list-style-type: none"> • Engine runs on 5 cylinders • Abnormal sound • Reduced performance | <ul style="list-style-type: none"> • Check that the injector cables are not damaged • Check that the injector connections are not damaged • Check fuel supply pressure • Check the valve clearance • Do a compression test and check cylinder #5 |

Injector, Cylinder #6 (Code 7.6, SID 6/SPN 656)

| Cause | Reaction | Remedy |
|--|---|---|
| <ul style="list-style-type: none"> • Electrical fault • Faulty compression or injector | <ul style="list-style-type: none"> • Engine runs on 5 cylinders • Abnormal sound • Reduced performance | <ul style="list-style-type: none"> • Check that the injector cables are not damaged • Check that the injector connections are not damaged • Check fuel supply pressure • Check the valve clearance • Do a compression test and check cylinder #6 |

Camshaft Drive Speed Sensor (Code 2.5, SID21/SPN 636)

| Cause | Reaction | Remedy |
|--|---|--|
| <ul style="list-style-type: none"> • No signal • Abnormal frequency • Fault in sensor | <ul style="list-style-type: none"> • Engine takes longer to start than normal. Engine runs normally when running | <ul style="list-style-type: none"> • Check that the engine speed sensor connector is correctly installed • Check that the engine speed sensor cable is not damaged • Check that the engine speed sensor is correctly installed in the upper timing gear cover. • Check engine speed sensor function. |

Flywheel Speed Sensor (Code 2.4, SID 22/SPN 637)

| Cause | Reaction | Remedy |
|---|---|--|
| <ul style="list-style-type: none"> • No signal • Abnormal frequency • "Intermittent" signal from the sensor • Fault in sensor | <ul style="list-style-type: none"> • Engine is very difficult to start and runs roughly when it starts | <ul style="list-style-type: none"> • Check that the sensor connector is correctly installed • Check that the engine speed sensor cable is not damaged • Check that the engine speed sensor is correctly installed in the flywheel housing • Check engine speed sensor function |

Data Link (CAN), CIU (Code 6.4, SID 231/SPN 639)

| Cause | Reaction | Remedy |
|---|--|---|
| <ul style="list-style-type: none"> Faulty data link (CAN), , CIU | <ul style="list-style-type: none"> Instruments and warning lamps stop working | <ul style="list-style-type: none"> Check that the 8-pin connector is not damaged Check that the cables between the CIU and the engine management unit are not damaged |

Data Link (CAN), EMS 2 (Code 6.5, SID 231/SPN 639/2017/PSID 201)

| Cause | Reaction | Remedy |
|--|--|---|
| <ul style="list-style-type: none"> Internal fault in control module | <ul style="list-style-type: none"> Engine not operating: engine can not be started. Engine operating: engine idles and can only be stopped with the auxiliary stop (AUX-stop) | <ul style="list-style-type: none"> Check that the 8-pin connector is not damaged Check that the cables between the CIU and the engine management unit are not damaged Check that sleeves 11 and 12 in the connector on the CIU are not damaged |

Power Supply Sensor (Code 9.3, SID 232/SPN 620)

| Cause | Reaction | Remedy |
|---|--|--|
| <ul style="list-style-type: none"> Shortcut Fault in sensor | <ul style="list-style-type: none"> Faulty values in oil pressure and boost pressure sensors Fault code for oil pressure- and boost pressure sensor Low engine output The instrument shows zero oil pressure and boost pressure | <ul style="list-style-type: none"> Check that the cable harness to oil pressure and boost pressure sensor has not been damaged Check oil pressure and boost pressure sensors |

Memory Fault EMS (Code 9.9, SID 240/SPN 628)

| Cause | Reaction | Remedy |
|--|--|---|
| <ul style="list-style-type: none"> Memory fault in engine management system | <ul style="list-style-type: none"> Engine might not start | <ul style="list-style-type: none"> Re-program the unit |

Faulty data link (J1587) (Code 9.2, SID 250/SPN 608)

| Cause | Reaction | Remedy |
|--|--|---|
| <ul style="list-style-type: none"> Faulty data link | <ul style="list-style-type: none"> None | <ul style="list-style-type: none"> Check that the 8-pin connector is not damaged Check that the cables between the CIU/DCU and the engine management unit are not damaged |

Data Set Memory EEPROM, CIU (Code 9.8, SID 253/SPN 630)

| Cause | Reaction | Remedy |
|--|---|--|
| <ul style="list-style-type: none"> Internal fault in control module Programming faulty | <ul style="list-style-type: none"> Engine does not start | <ul style="list-style-type: none"> Re-program the control module. |

Data Set Memory EEPROM, EMS (Code 9.9, SID 253/SPN 630)

| Cause | Reaction | Remedy |
|---|---|--|
| <ul style="list-style-type: none">• Internal fault in control module• Internal fault in control module | <ul style="list-style-type: none">• Engine does not start | <ul style="list-style-type: none">• Re-program the control module. If the fault remains, change the control module |

Fault in Control Unit, CIU (Code 9.8, SID 254/SPN 629)

| Cause | Reaction | Remedy |
|--|--|---|
| <ul style="list-style-type: none">• Faulty EEPROM, CIU• Faulty flash memory, CIU• Fault in control module, CIU | <ul style="list-style-type: none">• CIU returns to factory setting• Engine goes to idle• Engine can not be started | <ul style="list-style-type: none">• Re-program the unit |

Control Module EMS (Code 9.9, SID 254/SPN 629)

| Cause | Reaction | Remedy |
|--|---|--|
| <ul style="list-style-type: none">• Internal fault in control module | <ul style="list-style-type: none">• Engine misfires• Engine does not start | <ul style="list-style-type: none">• Change engine control unit |

Maintenance Schedule

Your Volvo Penta engine and its equipment are designed for high reliability and long life. It is built so as to have minimal environmental impact. If given preventive maintenance, according to the maintenance schedule, and if Volvo Penta original spares are used, these properties are retained and unnecessary malfunctions can be avoided.

CAUTION!

Read the chapter on Maintenance before starting work. It contains instructions on how to carry out maintenance and service operations in a safe and correct manner.

When both operation and calendar time are specified, perform the maintenance job at the interval which is reached first.

Service program

FSI = First Service Inspection

S = Special Service

A - F = Type of service (regular service)

C = Clean

R = Replace

L = Lubrication

I = Inspection (includes, if necessary, cleaning, adjustment, lubrication and change)

FSI = First Service Inspection

| | |
|---|---|
| After the first 100-200 Hours | |
| Fuel pre-filter, draining water / contamination | I |
| Coolant Level | I |
| Drive Belts | I |
| Start and warm up engine | |
| Coolant/oil/fuel, leakage | I |
| Inspection with VODIA (Diagnostic Tool) | I |
| Engine and transmission, abnormal noises | I |
| Stop engine | |
| Engine Oil and Oil Filters / By-pass filter | R |
| Restart engine | |
| Oil pressure / oil leakage | I |

S

| Every 50-600 Hours | | At least every (month) | | |
|---|---|------------------------|----|----|
| | | 12 | 24 | 48 |
| Engine Oil and Oil Filters / By-pass filter | R | • | | |

S

| | |
|-----------------------------------|---|
| After the First 1000 Hours | |
| Valve clearance | A |

| Every 50-600 Hours | | At least every (month) | | |
|---|---|------------------------|----|----|
| | | 12 | 24 | 48 |
| Engine Oil and Oil Filters / By-pass filter | R | • | | |

A

| Every 500 hours | | At least every (month) | | |
|---|---|------------------------|----|----|
| | | 12 | 24 | 48 |
| Fuel Tank (sludge trap), Drain | R | • | | |
| Inspection with VODIA (Diagnostic Tool) | I | • | | |
| Fuel pre-filter, draining condensed water | I | • | | |
| Air Filter Inserts (Indicator), Engine | I | • | | |
| Radiator | I | • | | |
| Drive Belts | I | • | | |
| Batteries, electrolyte level | I | • | | |

B

| Every 1000 hours | | At least every (month) | | |
|--|---|------------------------|----|----|
| | | 12 | 24 | 48 |
| Fuel Filter | R | • | | |
| Air filter insert | R | • | | |
| Fuel pre-filter | R | • | | |
| Coolant filter (if fitted). Not at same time as coolant change | R | • | | |

C

| Every 2000 Hours | |
|------------------|---|
| Valve clearance | I |

D

| Every 2000 Hours | | At least every (month) | | |
|---------------------------------|---|------------------------|----|----|
| | | 12 | 24 | 48 |
| Turbo | I | | • | |
| Turbo, Wastegate | I | | • | |
| Engine, with Respect to Leakage | I | | • | |
| Engine hoses, cables and clamps | I | | • | |
| Engine, cleaning and painting | I | | • | |
| Air Filter, Tank Breather | R | | • | |
| Air Filter, Compressor | R | | • | |

E

| Every 4000 hours | | At least every (month) | | |
|------------------|---|------------------------|----|----|
| | | 12 | 24 | 48 |
| Belt Tensioner | I | | • | |
| Drive Belts | R | | • | |
| Coolant (green) | R | | • | |

F

| Every 8000 hours | | At least every (month) | | |
|----------------------|---|------------------------|----|----|
| | | 12 | 24 | 48 |
| Coolant VCS (yellow) | R | | | • |

Maintenance

This chapter describes the most common maintenance items, see *Service program* for service intervals.

NOTICE! Service points which are not described here must be performed by authorized Volvo Penta workshop.

⚠ CAUTION!

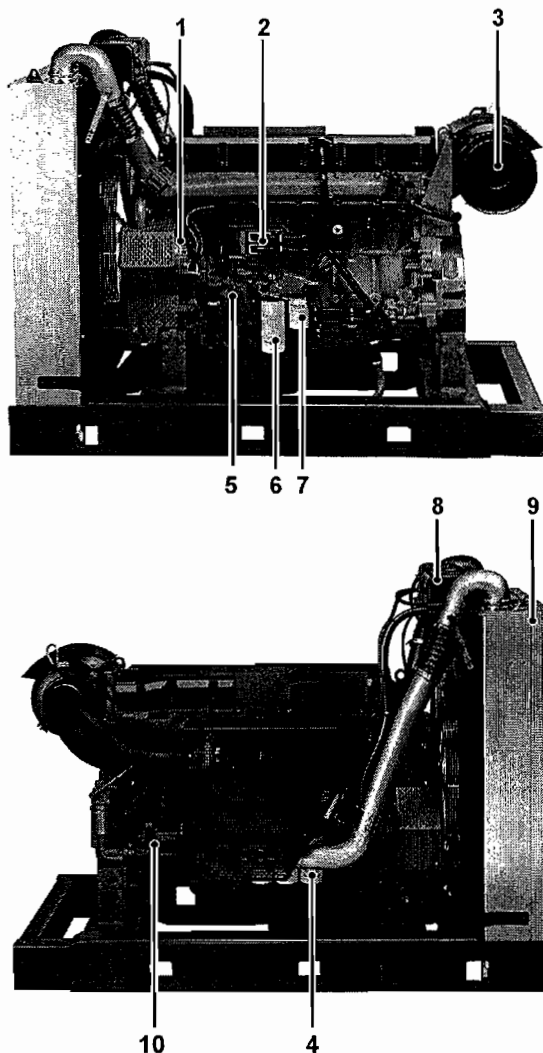
Read the chapter on Maintenance before starting work. It contains instructions on how to carry out maintenance and service operations in a safe and correct manner.

⚠ WARNING!

Care and maintenance work should be done with the engine stopped unless otherwise specified. Stop the engine before opening or removing the engine hatch/hood. Make it impossible to start the engine by removing the start key and cutting the system voltage with the main switches.

Read about security measures for maintenance and service in the chapter *Safety Information* page 3 before you begin.

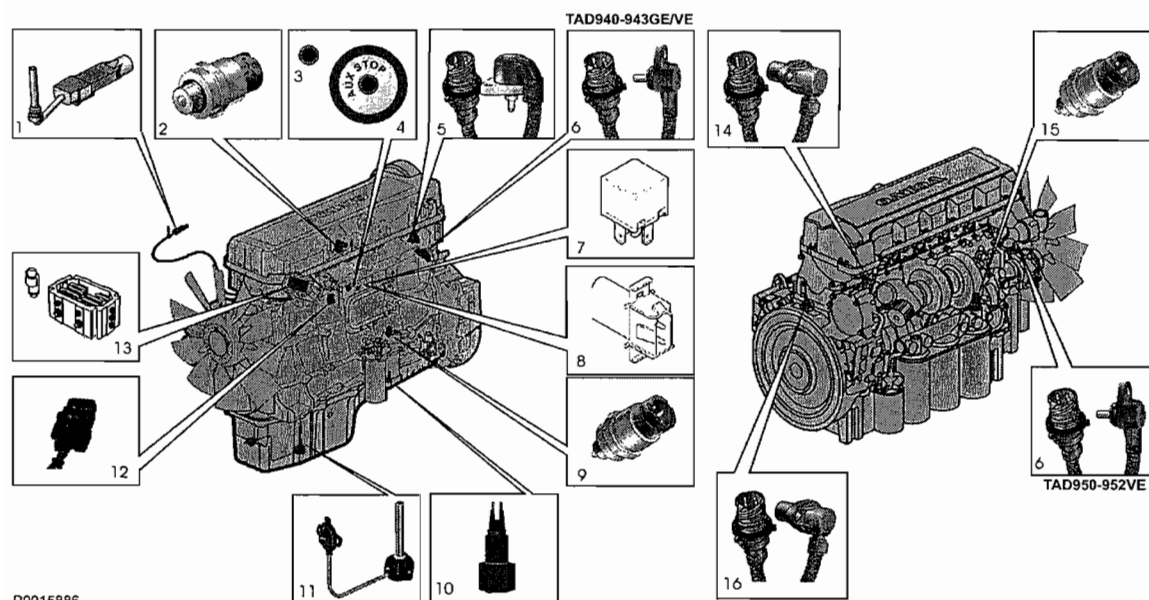
Orientation



- 1 Alternator
- 2 Control unit EMS 2
- 3 Air Filter
- 4 Oil dipstick
- 5 Fuel filter, with fuel pressure monitor
- 6 Fuel prefilter with water monitor
- 7 Expansion tank
- 8 Charge air cooler (only TAD)
- 9 Starter motor
- 10 Oil Filter

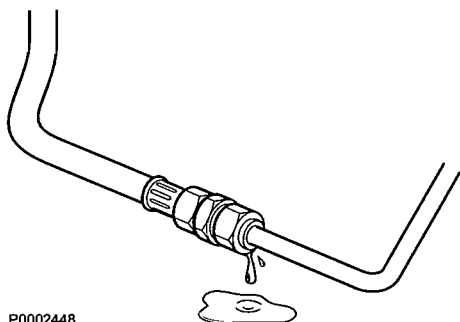
P0014600

Location of Sensors

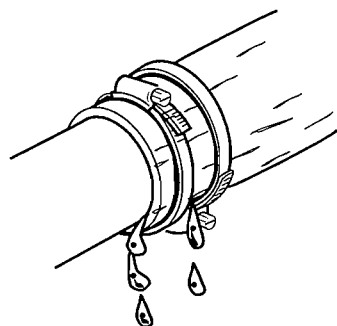


P0015886

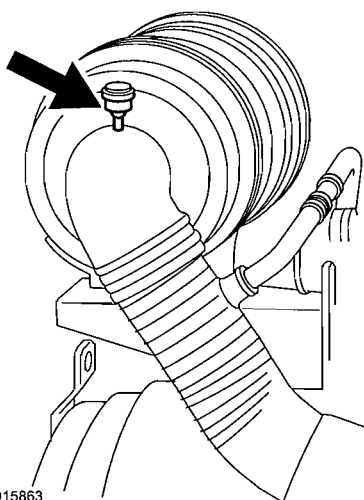
- | | |
|---|-----------------------------------|
| 1 Coolant level sensor | 9 Fuel pressure sensor |
| 2 Crankcase Pressurer | 10 Water in fuel indicator |
| 3 Electric feed pump switch | 11 Oil and temperature sender |
| 4 Auxiliary stop | 12 Main fuse |
| 5 Charge air pressure / Intake manifold temperature | 13 Preheater with preheater relay |
| 6 Coolant temperature sensor | 14 Camshaft sensor |
| 7 Main relay | 15 Flywheel sensor |
| 8 Diagnosis connector | |
| 2-pin: TAD940-43VE, TAD940-941GE | |
| 6-pin: TAD950-51VE | |



P0002448



P0002455



P0015863

Engine, General

General inspection

Make it a habit to give the engine and engine bay a visual inspection before starting the engine and after operation once the engine has stopped. This will help you to discover quickly if anything abnormal has happened, or is about to happen.

Look especially carefully at oil, fuel and coolant leakage, loose bolts, worn or poorly tensioned drive belts, loose connections, damaged hoses and electrical cables. This inspection only takes a few minutes and can prevent serious malfunctions and expensive repairs.

⚠ WARNING!

Accumulations of fuel, oil and grease on the engine or in the engine room is a fire hazard and must be removed immediately they are detected.

⚠ WARNING!

If an oil, fuel or coolant leak is detected, the cause must be investigated and the fault rectified before the engine is started.

IMPORTANT!

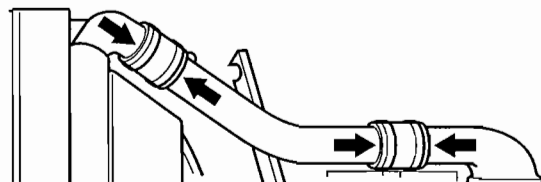
Remember the following when washing with a power washer: Never aim the water jet at radiators, charge air cooler, seals, rubber hoses or electrical components.

Air Filter, Check and Change

The engine is equipped with electronic air filter indication.

The control unit provides an output signal which is announced as a warning on the instrument panel. The warning indicates a pressure drop in the air filter, which must then be checked and possibly changed.

- Scrap the old filter. No cleaning or re-use is permissible
- In continuous operation, the filter should be checked every 8 hours. For operations in extremely dirty environments such as coal mines and rock crushing mills, special air filters must be used.



P0015859

Charge Air Pipe, Leakage Check

Inspect the condition of the charge air hoses, hose unions and clamp condition for cracks and other damage. Change as necessary.

IMPORTANT!

Clamps must be tightened using a torque wrench to 9 ± 2 Nm (6.6 ± 1.5 lbf.ft.).

Drive Belt and Alternator Belt, Inspection

Inspections must be carried out after operations, while the belts are hot.

You should be able to depress the alternator belt and the drive belt about 3-4 mm between the pulleys.

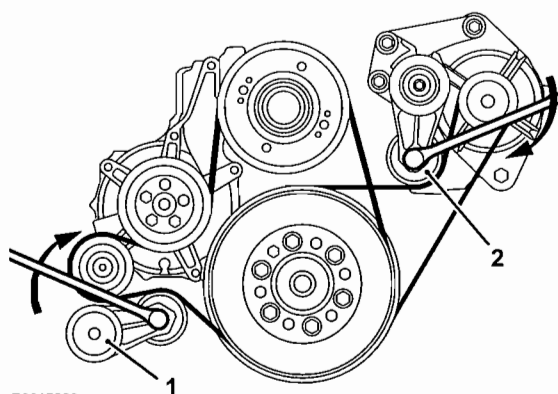
The alternator belts and drive belts have automatic belt tensioners and do not need to be adjusted.

Check the condition of the drive belts. Replace as necessary; refer to *Alternator Belt, Change* page 51 and *Drive Belt, Change* page 52.

Alternator Belt, Change

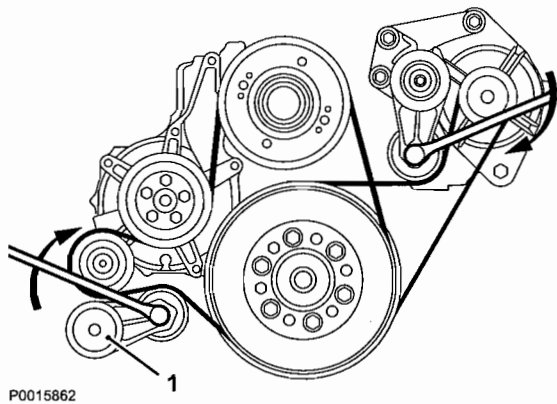
IMPORTANT!

Always change a drive belt which appears worn or cracked.



P0015860

- 1 Disconnect the main switch(es) and check that the engine is not connected to system voltage.
- 2 Remove the fan guard and fan ring round the cooling fan.
- 3 Remove the belt guard.
- 4 Insert a 1/2" square wrench in the belt tensioner (1). Lift the wrench up and lift the water pump drive belt off.
- 5 Insert a 1/2" square wrench in the belt tensioner (2). Press the wrench down and remove the alternator belts.
- 6 Check that the pulleys are clean and undamaged.
- 7 Press the 1/2" wrench in the belt tensioner (2) down and install the new alternator drive belt.
- 8 Lift the 1/2" wrench in the belt tensioner (2) and install the new water pump drive belt.
- 9 Install the belt guards.
- 10 Install the fan guard and fan ring round the cooling fan.
- 11 Start the engine and do a function check.

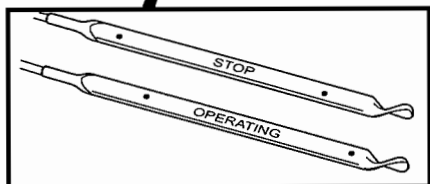
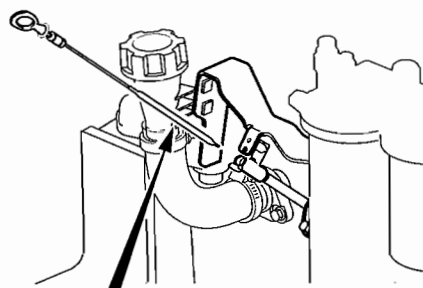


Drive Belt, Change

- 1 Disconnect the main switch(es) and check that the engine is not connected to system voltage.
- 2 Remove the fan guard and fan ring round the cooling fan.
- 3 Remove the belt guard.
- 4 Insert a 1/2" square wrench in the belt tensioner (1). Lift the wrench and remove the drive belt.
- 5 Thread the drive belt round the fan and remove it.
- 6 Check that the pulleys are clean and undamaged.
- 7 Thread the new drive belt over the fan.
- 8 Lift the 1/2" wrench and install the new drive belt.
- 9 Install the belt guards.
- 10 Install the fan guard and fan ring round the cooling fan.
- 11 Start the engine and do a function check.



P0002089



P0004311

Lubrication System

Oil change intervals may vary according to the lubrication oil grade and fuel sulfur content. **Refer to Technical data, Lubrication system.**

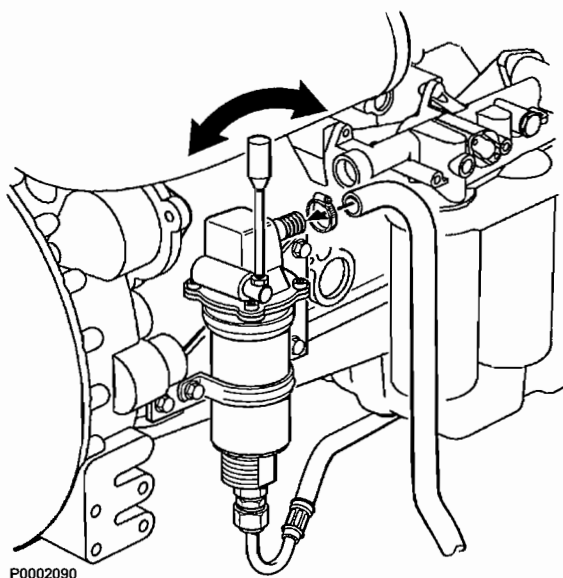
NOTICE! Oil change intervals must never exceed a period of 12 months.

If longer oil change intervals than those given in Technical data are required, the condition of the oil must be checked by the oil manufacturer via regular oil tests.

Oil level, checking and topping up

The oil level must be inside the marked area on the oil dipstick and must be checked daily before the first start.

- The oil level can be read both when the engine is stopped (the STOP side of the dipstick) and when it is running (the OPERATING side of the dipstick). Never fill past the MAX limit on the oil dipstick. Only use Volvo Penta recommended oils; refer to *Technical Data page 72*.
- Only fill when the engine is stopped. Fill oil through the oil filler; refer to *Maintenance page 48*. Check that the correct level is attained; wait a few minutes before reading off the level so that the oil has time to run down into the oil sump.
- The oil level sensor only measures the oil level when the ignition is switched to on, i.e. not continually during operation.



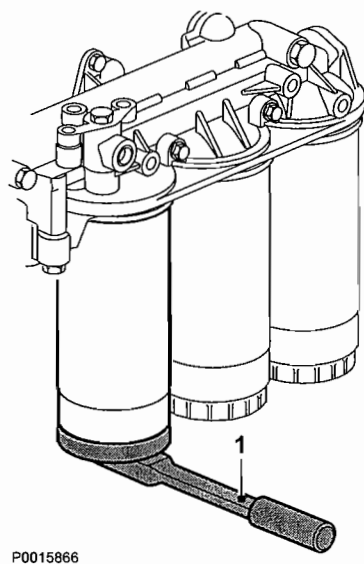
Engine Oil, Change

⚠ WARNING!

Hot oil and hot surfaces can cause burns.

Oil changes must be done when the engine is warm.

- 1 Connect the drain hose to the oil drain pump and check that no leakage can occur.
- 2 Pump the oil out (or remove the bottom drain plug and drain the oil).
Collect all the old oil and old filters, and leave them at a re-cycling station for destruction.
- 3 Remove the drain hose (or install the bottom drain plug).
- 4 Fill with engine oil.
For change volume, please refer to *Technical Data* page 72.



Oil Filter/By-pass Filter, Change

⚠ WARNING!

Hot oil and hot surfaces can cause burns.

- 1 Clean the oil filter bracket (2).
- 2 Remove all oil filters with a suitable oil filter extractor (1).
- 3 Clean the mating surface of the oil filter bracket.
Make sure that no pieces of old oil seal are left behind. Carefully clean round the inside of the protective rim (2) on the oil filter bracket.
- 4 Put a thin layer of engine oil on the seal rings of the new fuel filters.
- 5 Install the new oil filters. Tighten the filters $\frac{3}{4}$ –1 turn after they touch.
- 6 Top up with engine oil, start the engine and let it run for 20-30 seconds.
- 7 Turn off the engine, check the oil level and top up as required.
- 8 Check sealing round the oil filters.

Fuel System

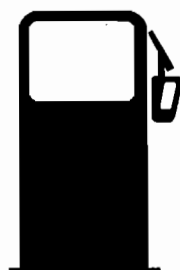
WARNING!

Fire hazard. When carrying out work on the fuel system make sure the engine is cold. A fuel spill onto a hot surface or an electrical component can cause a fire. Store fuel soaked rags so that they can not cause fire.

Only use the grades of fuel recommended in the fuel specification below, please refer to *Technical Data page 73*. Always observe the greatest cleanliness during re-fueling and work on the fuel system.

IMPORTANT!

All work on the injection system of the engine must be done by an authorized workshop.



P0002101

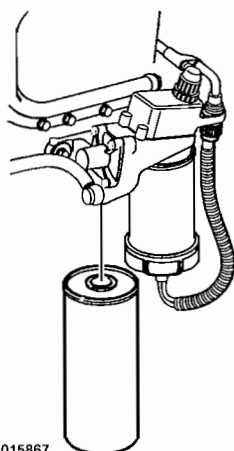
Engine Fuel Filter Replacement

WARNING!

Fire hazard. When carrying out work on the fuel system make sure the engine is cold. A fuel spill onto a hot surface or an electrical component can cause a fire. Store fuel soaked rags so that they can not cause fire.

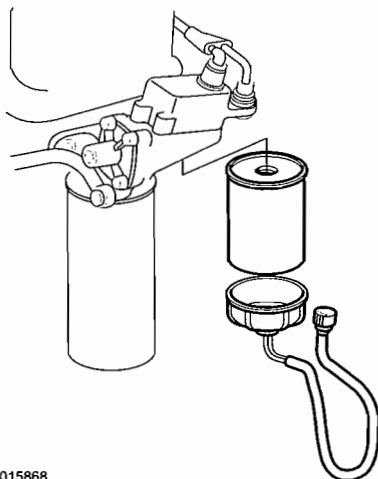
IMPORTANT!

Do not fill the new fuel filter with fuel before assembly. There is a risk that contamination could get into the system and cause malfunctions or damage.



P0015867

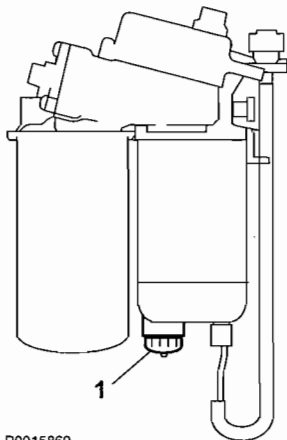
- 1 Clean round the fuel filter.
- 2 Remove the filter with a suitable filter remover. Collect any spilled fuel in a collection vessel.
- 3 Clean the filter mating surface on the filter bracket.
- 4 Lubricate the seal with diesel fuel and install the new fuel filter. Tighten the fuel filter in accordance with the instructions on the fuel filter.
- 5 If necessary, vent the fuel system, please refer to *Bleeding the Fuel System page 57*.



P0015868

Fuel Pre-filter, Change

- 1 Undo the cable from the water trap sensor.
- 2 Remove the water trap filter from the filter housing. Collect any spilled fuel in a container.
- 3 Remove the lower part of the water trap from the filter.
- 4 Clean the lower part of the water trap with a soft rag. Check that the drain hole in the lower part is not blocked.
- 5 Install a new seal on the lower part and lubricate the seal with diesel fuel. Re-install the lower part of the filter.
- 6 Lubricate the seal with diesel fuel. Screw the filter onto the filter bracket by hand until the rubber seal just touches the mating surface. Then tighten a further half turn, no more.
- 7 Connect the cable to the water trap sensor.
- 8 If necessary, vent the fuel system, please refer to *Bleeding the Fuel System* page 57.

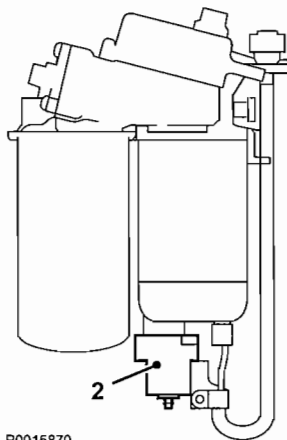


P0015869

Draining condensate, fuel system

NOTICE! Put a collection vessel under the fuel filter to collect the condensate and fuel.

- 1 Open the drain nipple (1) in the base of the fuel pre-filter.
- 2 Tighten the drain tap (1) when water-free fuel begins to run out.



P0015870

With electric drain nipple.

(only as option on VE engines)

NOTICE! Put a collection vessel under the fuel filter to collect the condensate and fuel.

- 1 Activate the electric drain nipple (2) at the base of the primary fuel filter to open it.
- 2 Press the electric feed pump switch until water-free fuel begins to run out; refer to Component locations.
- 3 Switch off the electric drain nipple (2) at the base of the primary fuel filter to close it.

Bleeding the Fuel System

- 1 Check whether there is enough fuel in the tank, and that any fuel taps are open.
- 2 Turn the ignition on.
- 3 The fuel system is vented by depressing the electric feed pump switch for 1 to 2 minutes.; refer to Component locations. Air is vented to the tank via the fuel return pipe. No venting nipples need be opened.
- 4 Start the engine and allow it to run at a fast idle for about 10 minutes.
- 5 Carry out a leakage and function check.

Cooling System

The engine's internal cooling system makes sure the engine works at the right temperature. It is a closed system that must always be filled with a mixture of concentrated coolant and water in order to protect the engine against internal corrosion, cavitation and bursts due to freezing.

IMPORTANT!

Coolant of a suitable chemical composition must be used all year round. This also applies in areas where there is never any risk of freezing, to provide the engine with full corrosion protection.

The corrosion protection additives become less effective over time, which means that the coolant must be changed at regular intervals; refer to the *Maintenance Schedule*. The cooling system must be flushed whenever the coolant is changed; refer to the *Cooling System, Cleaning* page 62 section.

Volvo Penta engines are delivered with either "Volvo Penta Coolant" (green) or "Volvo Penta Coolant VCS" (yellow); both are available as concentrates and "Ready Mixed".

Volvo Penta coolants have been prepared to work best with Volvo Penta engines and offer excellent protection against corrosion, cavitation damage, and bursts due to freezing. Only coolants of this quality are adapted to, and approved by, Volvo Penta.

We recommend that the coolant supplied with the engine on delivery be used. Future warranty claims related to engine and accessories may be declined if an unsuitable coolant has been used, or if the instructions for coolant mixture have not been followed. The use of anti-corrosion agents alone is not permitted in Volvo Penta engines. Never use water alone as a substitute for coolant.

IMPORTANT!

- The two types of Volvo Penta coolant may **never** be mixed with each other as this will affect the anti-corrosion properties.
- Coolant filters may not be used together with Volvo Penta Coolant VCS.
- Engines using yellow Volvo Penta Coolant VCS must have a yellow decal with the text VOLVO COOLANT VCS on the expansion tank.

Ready Mixed

Ready mixed coolant contains 40% Volvo Penta Coolant / Volvo Penta Coolant VCS and 60% water. This mixture protects the engine against internal corrosion, cavitation and bursts due to freezing down to -28°C (-18°F).



P0013077

Coolant, Mixing

The concentrated coolant must be mixed with pure water (distilled or de-ionized water) according to specifications; refer to *Water Quality* page 74.



WARNING!

All coolant is hazardous and harmful to the environment. Do not consume. Coolant is flammable.

IMPORTANT!

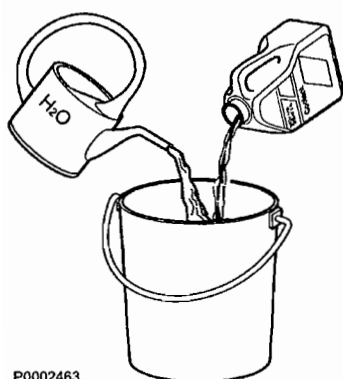
Different kinds of coolant must not be mixed with each other!

Mix: 40% concentrated coolant and 60% water

This mixture protects against internal corrosion, cavitation and bursts due to freezing down to -28°C (-18°F). A 60% glycol admix lowers the freezing point to -54°C (-65°F).

Never mix more than 60% concentrate in the coolant. A greater concentration provides reduced cooling effect with the risk for overheating and reduced anti-freeze protection.

It is extremely important that the system be filled with the correct coolant concentration. Mix in a separate clean vessel before filling the cooling system. Make sure that the liquids mix.



P0002463

Coolant Level, Checking and Topping Up

⚠ WARNING!

Do not open the coolant filler cap when the engine is warm, except in emergencies, this could cause serious personal injury. Steam or hot fluid could spray out.

IMPORTANT!

Filling of coolant must be performed with the engine stopped. Fill slowly to allow air to flow out.

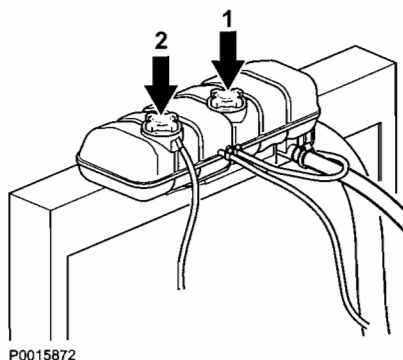
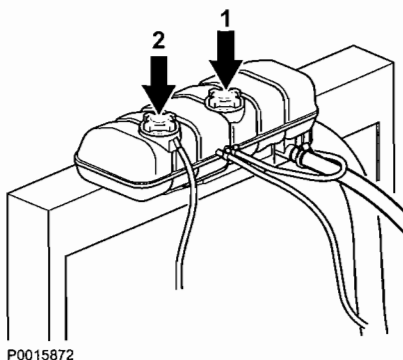
Coolant Level, Checking and Topping Up

NOTICE! Only use the coolant recommended by Volvo Penta.

NOTICE! Open only the filler cap (1). Do not open the pressure cap (2).

Check the coolant level daily before starting.

- 1 Check that the coolant level is above the MIN mark on the expansion tank.
- 2 Top up with coolant as required, so that the level is between the MIN and MAX marks.

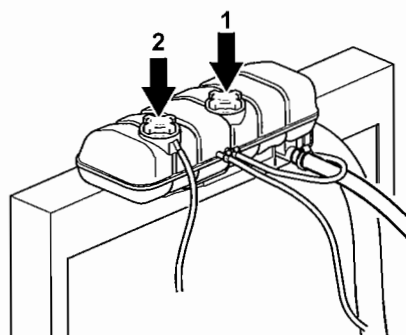


Filling a completely empty system

NOTICE! Mix the correct amount of coolant in advance to ensure that the cooling system is completely filled. Refer to *Technical Data* page 74 for the correct coolant quantity.

NOTICE! Do not start the engine until the system is vented and completely filled.

- 1 Check that all drain points are closed.
- 2 Open the filler cap (1). Do not open the pressure cap (2).
- 3 Fill with coolant so that the level is between the MIN and MAX marks.
- 4 Start the engine when the cooling system has been completely filled and vented. Open any venting taps a short while after starting, to allow trapped air to escape.
If a heating unit is connected to the engine cooling system, the heat control valve must be opened and the installation vented during filling.
- 5 Stop the engine after about an hour and check the coolant level; top off as necessary.



P0015872

Coolant, Draining

⚠ WARNING!

Do not open the coolant filler cap when the engine is warm, except in emergencies, this could cause serious personal injury. Steam or hot fluid could spray out.

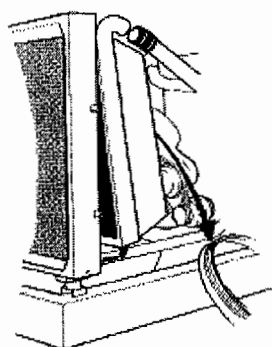
IMPORTANT!

Do **not** drain the engine cooling system if the engine is to be laid up or put in storage. The coolant contains corrosion protection additives.

NOTICE! Do not open the pressure cap (2).

- 1 Stop the engine before draining the coolant.
- 2 Remove the filler cap (1).
- 3 Open all drain points. Drain the coolant from the radiator and engine block using a drain hose. The drain nipples are located under the radiator on the right side of the engine block.
- 4 Check that all coolant drains out. Deposits may be found inside the drain plug/tap; they must to be cleared away. There is otherwise a risk that coolant could remain and cause damage due to freezing. Check whether the installation has any further taps or plugs at the lowest points of the coolant lines.
- 5 Shut any taps and check that the spring-loaded covers on the nipples close completely. Install the rubber plugs.

Charge Air Cooler, External Cleaning

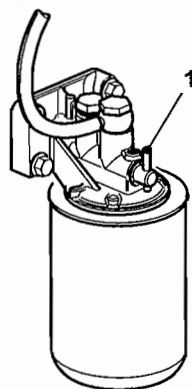


Remove guards as necessary, to access the radiator. Clean with water and a mild detergent. Use a soft brush. Be careful not to damage the radiator vanes. Reinstall removed parts.

IMPORTANT!

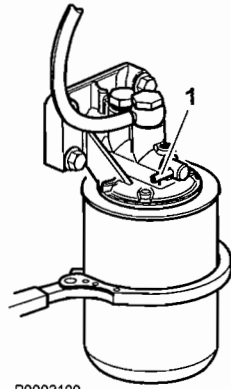
Do not use a pressure washer.

Open



P0002099

Closed



P0002100

Coolant Filter, Change

NOTICE! Only applies to engines using Volvo Penta Coolant (green). Engines using Volvo Penta Coolant VCS are not fitted with coolant filters.

- 1 Turn the tap (1) 90° to stop the flow through the coolant filter.
- 2 Remove the coolant filter with a suitable extractor. Make sure that no residue from the old seal remains in the housing.
- 3 Put a thin layer of engine oil on the new coolant filter seal. Screw the coolant filter on by hand until the seal comes into contact with the mating surface of the filter bracket. Then tighten the coolant filter a further 1/2 turn.
- 4 Turn the tap (1) 90° to release the flow through the coolant filter again.
- 5 Start the engine and perform a leakage check.
- 6 Switch the engine off and check the coolant level. Refer to *Coolant Level, Checking and Topping Up* page 60.

Cooling System, Cleaning

Cooling performance is reduced by deposits in the radiator and cooling galleries. The cooling system should be cleaned out when the coolant is changed.

IMPORTANT!

Cleaning must not be done if there is any risk of the cooling system freezing, since the cleaning solution does not have any frost prevention ability.

IMPORTANT!

It is extremely important that the correct concentration and volume of coolant is put in the system. Mix in a separate clean vessel before filling the cooling system. Make sure that the liquids mix.

- 1 Empty the cooling system. Refer to *Coolant, Draining* page 61.
- 2 Put a hose into the expansion tank filling hole and flush with clean water, as specified by Volvo Penta—refer to section Water quality in *Technical Data* page 74 until the water draining out is completely clear.
- 3 If there should still be some contamination left after flushing for a long time, cleaning can be done with coolant. Otherwise, continue as in item 8 below.
- 4 Fill the cooling system with 15-20 % mixture of concentrated coolant. Use only Volvo Penta recommended concentrated coolant mixed with clean water.

- 5 Drain the coolant after 1-2 days of operation. Remove the filler cap and possibly the lower radiator hose to increase the speed of emptying. To prevent suspended material from settling back in the system, emptying should be done rapidly, within the space of 10 minutes, when the engine has not been standing still for a long time.
- 6 Flush the system immediately and thoroughly with clean hot water to prevent dirt from settling in the inner areas. Flush until the water that runs out is completely clean. Make sure that any heater controls are set to full heating during emptying.
- 7 If contamination should still be left after a long period of flushing, you can do a cleanout with Volvo Penta radiator cleaner, followed by finishing-off with Volvo Penta neutralizer. Carefully follow the instructions on the package. Otherwise, continue as in item 8 below.
- 8 When the cooling system is completely free from contamination, close the drain taps and plugs.
- 9 Fill up with Volvo Penta recommended coolant, following the instructions in the chapters entitled *Maintenance page 58* and *Coolant Level, Checking and Topping Up page 60*.

Electrical System

The engine is equipped with a 2-pole electrical system and an alternator. System voltage is 12V or 24V.

WARNING!

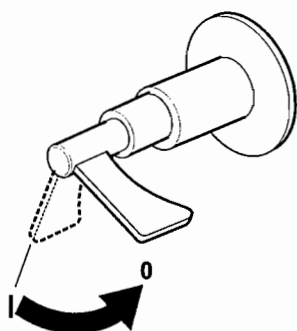
Always stop the engine and break the current using the main switches before working on the engine.

Main switch

IMPORTANT!

Never disconnect the current with the main switches when the engine is running, the alternator and electronics could be damaged.

The main switches must never be switched off before the engine has stopped. If the circuit between the alternator and the battery is disconnected when the engine is running, the alternator and electronics can be damaged. For the same reason the charging circuits must never be re-connected with the engine running.



P0002576

Fuses

The engine is equipped with a 10 A circuit breaker which cuts the current if overloaded.

The circuit breaker is located on the left-hand side of the engine *Location of Sensors page 49*.

The engine stops if the fuse trips. If the circuit breaker trips frequently, an authorized Volvo Penta workshop should be contacted to investigate the cause of the overload.

Electrical Connections

Check that electrical connections are dry, free from oxide, and that they are securely tightened. Spray the connections as necessary with water-repellent spray (Volvo Penta universal oil).



P0002479



P0002107

Battery, Maintenance

WARNING!

Risk of fire and explosion. Never allow an open flame or electric sparks near the battery or batteries.

WARNING!

Never confuse the positive and negative poles on the batteries. Risk of arcing and explosion.

WARNING!

The battery electrolyte contains extremely corrosive sulfuric acid. Protect your skin and clothes when charging or handling batteries.

Always use protective goggles and gloves. If battery electrolyte comes into contact with unprotected skin wash off immediately using plenty of water and soap. If battery acid comes in contact with the eyes, flush immediately with plenty of water and obtain medical assistance without delay.

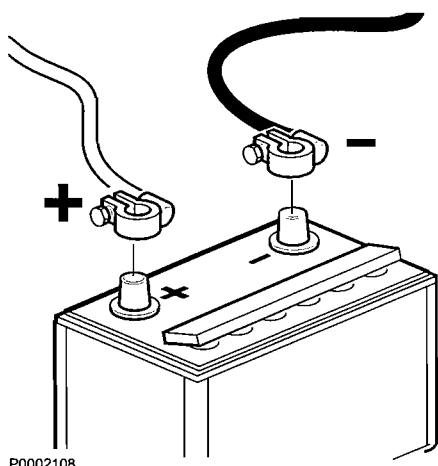
Connecting and disconnecting the battery

Connecting

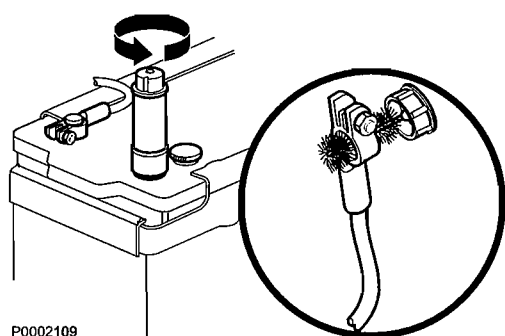
- 1 Connect the + cable (red) to the + pole on the battery.
- 2 Connect the – cable (black) to the – pole on the battery.

Disconnecting

- 1 Remove the – cable (black).
- 2 Remove the + cable (red).



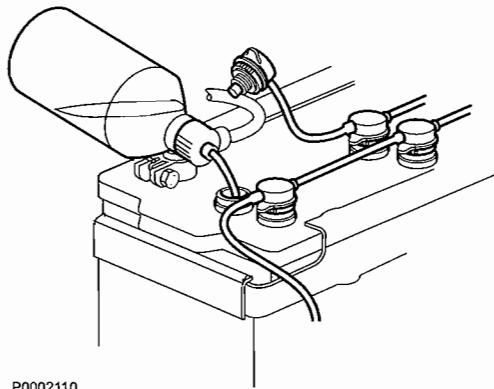
P0002108



P0002109

Cleaning

Keep the batteries clean and dry. Contamination and oxide on the batteries and battery poles can cause stray currents, voltage drop and discharge, especially in wet weather. Remove oxidation from the battery poles and terminals, using a brass brush. Tighten the terminals securely and grease them with terminal grease or petroleum jelly.



P0002110



P0002107

Filling

The electrolyte level should be 5–10 mm (0.2– 0.4") above the cell plates in the battery. Top up with distilled water as required.

After filling, the battery should be charged for at least 30 minutes by running the engine at idle.

Some maintenance-free batteries have special instructions, which must be followed.

Battery, Charging



WARNING!

Risk of fire and explosion. Never allow an open flame or electric sparks near the battery or batteries.



WARNING!

The battery electrolyte contains extremely corrosive sulfuric acid. Protect your skin and clothes when charging or handling batteries.

Always use protective goggles and gloves. If battery electrolyte comes into contact with unprotected skin wash off immediately using plenty of water and soap. If battery acid comes in contact with the eyes, flush immediately with plenty of water and obtain medical assistance without delay.



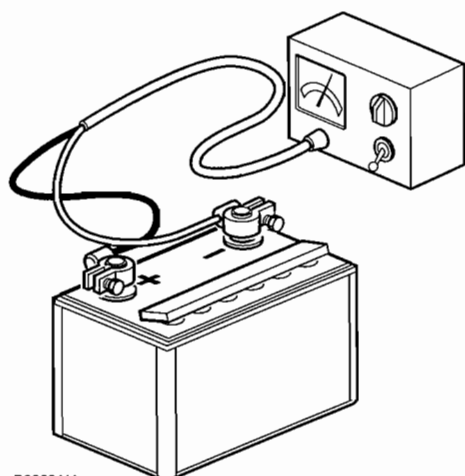
WARNING!

Never confuse the positive and negative poles on the batteries. Risk of arcing and explosion.

IMPORTANT!

Observe the instruction manual for the battery charger carefully. To avoid the risk of electrochemical corrosion when an external charger is connected, the battery cables should be removed from the batteries before the charger is connected.

Always switch off the charging current before the charging clips are removed.



P0002111

- Charge batteries if they have become discharged. During charging, unscrew the cell plugs but leave them in the plug holes. Ventilate well, especially if the batteries are charged in an enclosed space.
- If the engine is not used for a longer period of time, the batteries should be fully charged, then possibly trickle charged (please refer to the battery manufacturer's recommendations). Batteries are damaged by being left discharged, and can also freeze and burst easier in cold weather.
- Special instructions apply to **boost charging**. Boost charging can shorten battery life, and should therefore be avoided.

Storage

The engine and other equipment must be laid up to prevent damage if they are not used for two months or more. It is important that this is done in the correct manner, and nothing is forgotten. For this reason, we have compiled a check list of the most important points.

Before the engine is taken out of service for a long period of time, an authorized Volvo Penta workshop should check it over. Have any faults and deficiencies attended to, so that the equipment is in order, ready for the next start.

⚠ CAUTION!

Read the chapter on Maintenance before starting work. It contains instructions on how to carry out maintenance and service operations in a safe and correct manner.

⚠ WARNING!

Conservation oils can be flammable and dangerous to breathe. Ensure good ventilation. Use a protective face mask when spraying.

IMPORTANT!

Remember the following when washing with a high pressure washer: Never aim the water jet at seals, rubber hoses or electrical components.



P0002089

- **For up to 8 month's stoppage:**
Change the oil and oil filter on the engine, then warm it up afterwards.
- **More than 8 month's stoppage:**
Conserve the lubrication and fuel systems with conservation oil. Please refer section *Conservation of the lubrication and fuel systems for more than 8 months' stoppage*.
- Check that the coolant offers sufficient frost protection. Top up as necessary.
Alternatively, you can drain the coolant (also drain the coolant filter).
- Drain any water and contamination from the fuel filters and fuel tank. Fill the fuel tank completely, to avoid condensation.
- Disconnect the battery cables, clean and charge the batteries. Trickle charge the batteries while the equipment is in storage. **A poorly charged battery can freeze and burst.**
- Clean the outside of the engine. Do not use a high pressure washer for engine cleaning. Touch up paint damage with Volvo Penta original paint.
- Spray the components of the electrical system with water-repellent spray.
- Check and rust-proof any control cables.
- Put a note on the engine with the date, type of conservation and the conservation oil used.
- Cover over the air filter, exhaust pipe and engine if necessary.

Bringing out of storage

- Remove any covers from the engine, air filter and exhaust pipe.
- Put the correct grade of oil into the engine, if necessary, refer to *Technical Data, Lubrication System*. Install a new oil filter if the filter was not changed during conservation.
- Install new fuel filters and vent the fuel system.
- Check the drive belt(s).
- Check the condition of all rubber hoses, and retighten the hose clamps.
- Close the drain taps and install any drainplugs.
- Check the coolant level. Top up as necessary.
- Connect the fully charged batteries.
- Start the engine and warm it up at fast idle with no loading.
- Check that no oil, fuel or coolant leakage occurs.

Conservation of the lubrication and fuel systems for more than 8 months' stoppage:

- Drain the engine oil and fill up with **conservation oil*** to just over the MIN marking on the dipstick.
- Connect the fuel suction and return hoses to a 1/3 full jerrican containing **conservation oil*** and 2/3 diesel fuel.
- Vent the fuel system.
- Start the engine and run at a fast idle until about 2 liters (0.6 US gals) of the fluid in the jerrican have been used. Stop the engine and connect the ordinary fuel pipes.
- Drain the engine's conservation oil.
- Follow the other instructions on the previous page.

* Conservation oils are sold by oil companies.

Technical Data

Engines

| Type designation | TAD940GE | TAD941GE |
|------------------------------------|-------------------------------|------------------------|
| Power, prime/stand-by | Refer to the sales literature | |
| Torque, Prime/Standby | Refer to the sales literature | |
| Compression ratio | 20.2:1 | 17.4:1 |
| Low idle, r/min. | 600–1200 | 600–1200 |
| High idle, rpm | 1500–1620 1800–1920 | 1500–1620 1800–1920 |
| Highest full load speed | 1500/1800 | 1500/1800 |
| No. of valves | 24 | 24 |
| No. of cylinders | 6 | 6 |
| Bore, mm (inch) | 120 (4.72) | 120 (4.72) |
| Stroke, mm (inch) | 138 (5.43) | 138 (5.43) |
| Displacement, (inch ³) | 9.36 (571) | 9.36 (571) |
| Weight, dry, kg (lbs) | 1015 (2238) | 1015 (2238) |
| Weight, wet, kg (lbs) | 1065 (2348) | 1065 (2348) |
| Firing order | 1-5-3-6-2-4 | 1-5-3-6-2-4 |

| Type designation | TAD940VE | TAD941VE | TAD942VE | TAD943 |
|------------------------------------|-------------------------------|-------------|-------------|-------------|
| Power, prime/stand-by | Refer to the sales literature | | | |
| Torque, Prime/Standby | Refer to the sales literature | | | |
| Compression ratio | 20.2:1 | 20.2:1 | 20.2:1 | 20.2:1 |
| Low idle, r/min. | 600 | 600 | 600 | 600 |
| High idle, rpm | 2250 | 2250 | 2250 | 2250 |
| No. of valves | 24 | 24 | 24 | 24 |
| No. of cylinders | 6 | 6 | 6 | 6 |
| Bore, mm (inch) | 120 (4.72) | 120 (4.72) | 120 (4.72) | 120 (4.72) |
| Stroke, mm (inch) | 138 (5.43) | 138 (5.43) | 138 (5.43) | 138 (5.43) |
| Displacement, (inch ³) | 9.36 (571) | 9.36 (571) | 9.36 (571) | 9.36 (571) |
| Weight, dry, kg (lbs) | 1015 (2238) | 1015 (2238) | 1015 (2238) | 1015 (2238) |
| Weight, wet, kg (lbs) | 1065 (2348) | 1065 (2348) | 1065 (2348) | 1065 (2348) |
| Firing order | 1-5-3-6-2-4 | 1-5-3-6-2-4 | 1-5-3-6-2-4 | 1-5-3-6-2-4 |

| Type designation | TAD950VE | TAD951VE | TAD952VE |
|------------------------------------|-------------------------------|-------------|-------------|
| Power, prime/stand-by | Refer to the sales literature | | |
| Torque, Prime/Standby | Refer to the sales literature | | |
| Compression ratio | 20.2:1 | 20.2:1 | 20.2:1 |
| Low idle, r/min. | 600 | 600 | 600 |
| High idle, rpm | 2250 | 2250 | 2250 |
| No. of valves | 24 | 24 | 24 |
| No. of cylinders | 6 | 6 | 6 |
| Bore, mm (inch) | 120 (4.72) | 120 (4.72) | 120 (4.72) |
| Stroke, mm (inch) | 138 (5.43) | 138 (5.43) | 138 (5.43) |
| Displacement, (inch ³) | 9.36 (571) | 9.36 (571) | 9.36 (571) |
| Weight, dry, kg (lbs) | 1015 (2238) | 1015 (2238) | 1015 (2238) |
| Weight, wet, kg (lbs) | 1065 (2348) | 1065 (2348) | 1065 (2348) |
| Firing order | 1-5-3-6-2-4 | 1-5-3-6-2-4 | 1-5-3-6-2-4 |

Lubrication System

| | |
|--|-------------------------|
| Oil | |
| Oil capacity including oil filters, approx.: | 35litre (9.25 US gal) |
| Oil pressure, hot engine: | |
| at operating speed | 300-600 kPa (44-87 psi) |
| Oil pressure during neutral | 270 kPa |
| Oil Filter | |
| Full flow filter | 2 |
| By-pass filter | 1 |
| Lube Oil Pump | |
| Type | Gear driven |

Oil recommendations

| Oil grade | Sulfur content in fuel, by weight | | |
|------------------------------|--|--------------------|-------------------------------|
| | up to 0,5 % | 0,5 – 1,0 % | more than 1,0 % ¹⁾ |
| | Oil change interval: Reached first in operation: | | |
| VDS-3 VDS-2 ²⁾ | 600 hrs / 12 month | 300 hrs / 12 month | 150 hrs / 12 month |

NOTICE! Mineral based oil, as well as fully or semi-synthetic, can be used on condition that it complies with the quality requirements above.

1) If sulfur content is > 1.0 % by weight, use oil with TBN > 15.

2) The oil must also comply with at least one of the following specifications ACEA:E7, ACEA:E5, Global DHD-1, API:CI-4 or API:CH-4.

VDS = Volvo Drain Specification

ACEA = Association des Constructeurs Européenne d'Automobiles

API = American Petroleum Institute Global

DHD = Global Diesel Heavy Duty

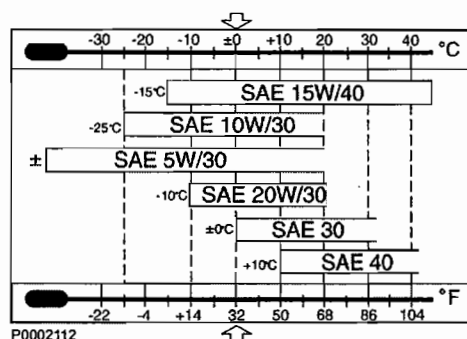
TBN = Total Base Number

Viscosity

Select the viscosity according to the table.

The temperature values refer to stable ambient temperatures.

* SAE 5W/30 refers to synthetic or semi-synthetic oils.



Fuel System

| | |
|----------------------------|-------------------------|
| Feed pump | |
| Feed pressure at 600 rpm | min 100 kPa (14.5 psi) |
| Feed pressure at 1200 rpm | min 300 kPa (43,5 psi) |
| Feed pressure at full load | min 300 kPa (43,5 psi) |
| Bypass valve | |
| Opening pressure | 400-550 kPa (58–80 psi) |

Fuel specification

The fuel must comply with national and international standards for commercially supplied fuels, such as:

EN 590 (with nationally adapted environmental and cold weather requirements)

ASTM D 975 No 1-D och 2-D

JIS KK 2204

Sulfur content: Complying with legal requirements in each country. If the sulfur content exceeds 0.5 weight-percent, the oil change intervals shall be changed, refer to *Technical Data page 72*.

Extremely low sulfur content fuel (urban diesel in Sweden and city diesel in Finland) can cause a loss of up to 5 % of power and an increase in fuel consumption of about 2-3 %.

Biodiesel (FAME)

Vegetable oil esters (Fatty Acid Methyl Esters, FAME), also called "biodiesel", are increasingly available as a blending component in diesel fuels. Volvo Penta accepts the same FAME content as in major on-road fuels EN 590 and ASTM D975; i.e. today up to 7%, without any specific additional service requirements. Please contact your Volvo Penta Dealer for further information.

For engines produced after 1 Jan 2009 Volvo Penta accepts, with specific service requirements,

- max 30% FAME blend (FAME component in accordance with EN 14214 and diesel fuel in accordance with EN 590)
- max 20% FAME blend (FAME component in accordance with ASTM D6751 and diesel fuel in accordance with ASTM D975)

NOTICE!

Higher FAME blends will negatively impact performance, emissions and fuel consumption. Furthermore the function of the Stage 3B engine exhaust aftertreatment system will be negatively affected.

NOTICE!

Engines for emergency applications, e.g. genset standby, must only run with market diesel fuel with minimum FAME content.

NOTICE!

Tier 4i engines must only run with market diesel fuel.

NOTICE!

In case of cold starting problems shift to diesel fuel. Do not to use FAME below -10°C.

NOTICE!

Raw vegetable or animal oils do not meet EN 14214 and are not allowed as fuels or fuel blending components.

Cooling System

| | |
|---|----------------------------|
| Type | Pressurized, sealed |
| Pressure cap, max. opening pressure | 75 kPa (10.88 PSI) |
| Coolant quantity (engine): | 33 liter (8.72 US gallon) |
| Coolant quantity (engine, radiator and hoses): | |
| TAD1640-42GE, TAD1641-43VE, TAD1650VE, TAD1650-51GE | 60 liter (15.85 US gallon) |
| TWD1643GE | 95 liter (25.1 US gallon) |
| Thermostat, quantity | 1 pc. |
| Thermostat, opening temperature: | |
| TAD1640-42GE, TAD1641-43VE | 86 °C (186.8 °F) |
| TAD1650VE, TWD1643GE | 82 °C (179.6 °F) |



P0013077

Coolant

Volvo Penta Coolant VCS and VCS Ready Mixed (yellow colour) are based on Organic Acid Technology, OAT.

Volvo Penta Coolant and Coolant Ready Mixed (green colour) are silicate based.



P0002094

Water Quality

ASTM D4985:

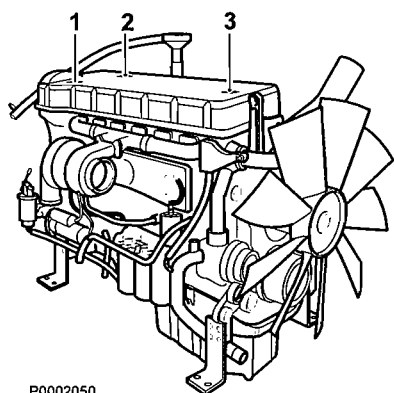
| | |
|---|-----------------------------|
| Total solid particles | <340 ppm |
| Total hardness | <9,5° dH |
| Chloride | <40 ppm |
| Sulfate | <100 ppm |
| pH value | 5.5-9 |
| Silica (acc. ASTM D859) | <20 mg SiO ₂ /l |
| Iron (acc. ASTM D1068) | <0.10 ppm |
| Manganese (acc. ASTM D858) | <0.05 ppm |
| Conductivity (acc. ASTM D1125) | <500 µS/cm |
| Organic content, COD _{Mn} (acc. ISO8467) | <15 mg KMnO ₄ /l |

Electrical System

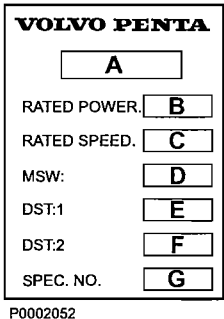
| | |
|--|---|
| System voltage | 24V |
| Alternator: | |
| voltage/max. current | 28V/80A |
| output app. | 2200 W |
| Alternative generating equipment (optional): | |
| voltage/max. current | 28V/100A |
| output app. | 2800 W |
| and | |
| voltage/max. current | 28V/140A |
| output app. | 4000 W |
| Battery capacity | 2 pcs series connected 12V, max. 180 Ah |
| Battery electrolyte specific gravity at +25°C: | |
| fully charged battery | 1.28 g/cm ³ (1.24 g/cm ³)* |
| re-charge battery at | 1.20 g/cm ³ (1.20 g/cm ³)* |

* Note: Applies to batteries with tropical acid.

Identification Numbers



1
Chassis and serial number



2
A Engine designation
B Engine power, net, (without fan)
C Max. engine speed
D Main software
E Dataset 1
F Dataset 2
G Product number



3
1 Engine designation
2 Serial number
3 Specification number

VOLVO PENTA

Declaration for the installation of partially-completed machinery in accordance with Machinery Directive 2006/42/EC

Engine Manufacturer:

AB Volvo Penta
Gropegårdsgatan
SE 405 08 Göteborg
Sweden

Description of engine: 4-cycle diesel engine

Engine types covered by this declaration:

TAD940GE
TAD941GE

TAD940VE
TAD941VE
TAD942VE
TAD943VE

TAD950VE
TAD951VE
TAD952VE

Fundamental health and safety requirements applied to, and fulfilled by, the above-mentioned engines are described in the following items in Annex I; 1.1.3, 1.4.2, 1.1.5, 1.5.1, 1.5.2, 1.5.3, 1.5.4, 1.5.6, 1.5.13, 1.6.1, 1.6.2, 1.6.4, 1.7.1, 1.7.1.1, 1.7.1.2, 1.7.4, 1.7.4.1 and 1.7.4.3.

The relevant technical documentation is compiled as described in part B of Annex VII.

Relevant information concerning the partially-completed machinery will be provided in suitable form upon justified requests from competent national authorities. The individual authorized to compile the relevant technical documentation is the signer of this declaration.

The harmonizing standards applied are:

EN ISO 12100-1: Safety of machinery - Basic concepts, general principles for design - Part 1: Basic terminology, methodology

EN ISO 12100-2: Safety of machinery - Basic concepts, general principles for design - Part 2: Technical principles

EN 1679-1: Reciprocating internal combustion engines - Safety - Part 1: Compression ignition engines

The partially-completed machinery also complies with the following relevant Directive:

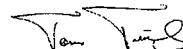
2004/108/EC - Electromagnetic Compatibility (EMC) Directive

Applied Standards: EN 61000-6-1, EN 61000-6-2, EN 61000-6-3, EN 61000-6-4, EN 12895, EN-ISO 14982 and EN 13309

These engines may not be put into operation before the completed machinery into which they are to be installed has been declared to conform with the provisions of Machinery Directive 2006/42/EC.

Name and function: Tom Tveitan, Laws and Regulation
(the identity of the individual authorized to sign on behalf of the engine manufacturer or the latter's authorized representative).

Signature and title:



Date and place of issue: (yyyy/mm/dd) 2011/02/17 Gothenburg

PL-22/11



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9.2. Appendix B - Alternator user and maintenance manual

User guide and maintenance manual

LEROY SOMER

Alternator

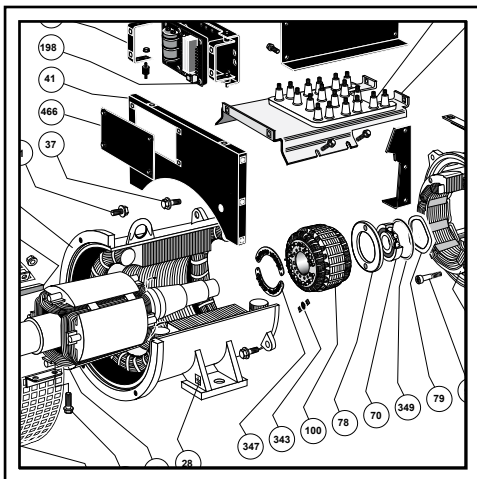
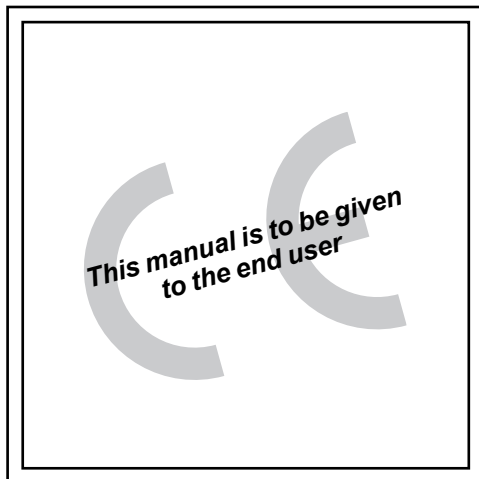
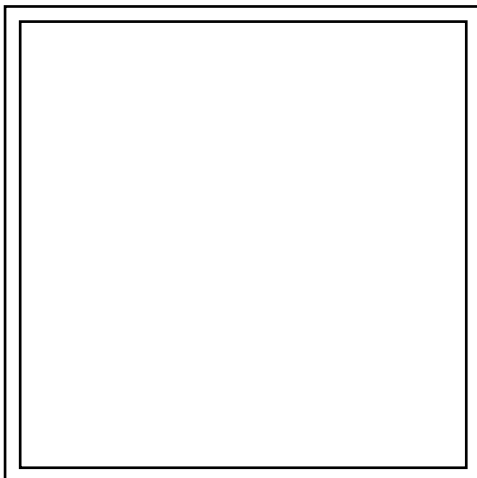
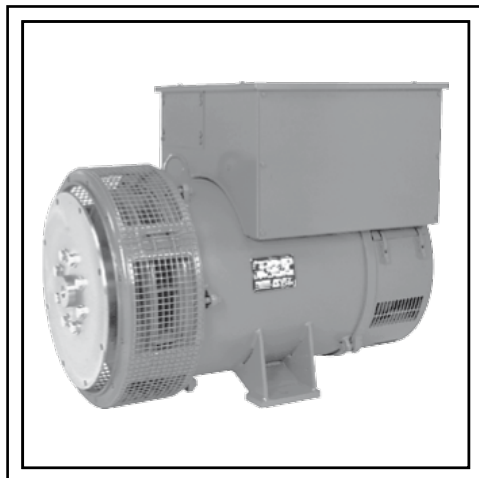
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LSA46.2 M3 - M5

46-2 SHUNT & AREP & PMG

3856 h
01/03/2012

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LSA 46.2 - 4 POLES ALTERNATORS

Installation and maintenance

LSA 46.2 - 4 POLES ALTERNATORS

This manual concerns the alternator which you have just purchased.

We wish to draw your attention to the contents of this maintenance manual.

SAFETY MEASURES

Before using your machine for the first time, it is important to read the whole of this installation and maintenance manual.

All necessary operations and interventions on this machine must be performed by a qualified technician.

Our technical support service will be pleased to provide any additional information you may require.

The various operations described in this manual are accompanied by recommendations or symbols to alert the user to the potential risk of accidents. It is vital that you understand and take notice of the different warning symbols used.

WARNING

Warning symbol for an operation capable of damaging or destroying the machine or surrounding equipment.



Warning symbol for general danger to personnel.



Warning symbol for electrical danger to personnel.

WARNING SYMBOLS

We wish to draw your attention to the following 2 safety measures which must be complied with:

a) During operation, do not allow anyone to stand in front of the air outlet guards, in case anything is ejected from them.

b) Do not allow children younger than 14 to go near the air outlet guards.

A set of self-adhesive stickers depicting the various warning symbols is included with this maintenance manual. They should be positioned as shown in the drawing below once the machine has been fully installed.

WARNING

The alternators must not be put into service until the machines in which they are to be incorporated have been declared compliant with Directives EC and plus any other directives that may be applicable.

Note: LEROY-SOMER reserves the right to modify the characteristics of its products at any time in order to incorporate the latest technological developments. The information contained in this document may therefore be changed without notice.

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| | | |
|---|------------------------------|----------------------|
| LEROY-SOMER | Installation and maintenance | 3856 en - 2011.01/ h |
| LSA 46.2 - 4 POLES ALTERNATORS | | |

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LSA 46.2 - 4 POLES ALTERNATORS

2 - TECHNICAL CHARACTERISTICS

1.1 - Electrical characteristics

The LSA 46.2 alternator is a machine without sliprings or revolving armature brushes, wound as "2/3 pitch", 6 or 12-wire, with class H insulation and a field excitation system available in either SHUNT, AREP or «PMG» version (see diagrams and AVR manuals).

2.1.1 - Electrical options

- Stator temperature detection sensors
- Bearing sensors (PTC, PT100, etc)
- Space heater

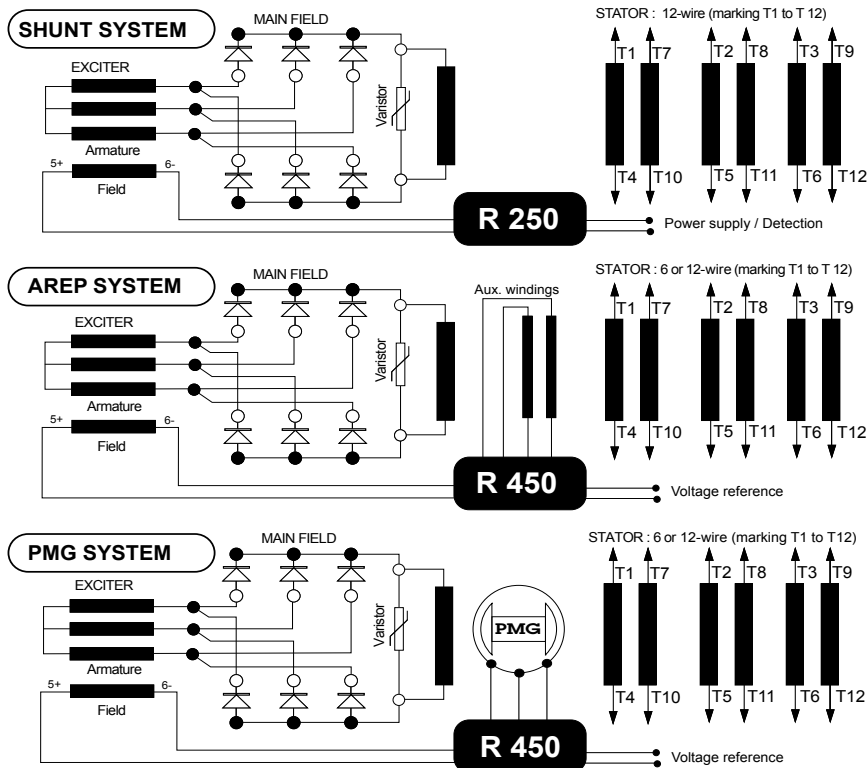
Interference suppression conforms to standard EN 55011, group 1, class B (Europe).

2.2 - Mechanical characteristics

- Steel frame
- Cast iron end shields
- Protected ball bearings, greased for life
- Mounting arrangements:
IM 1201 (MD 35) foot and flange mounted, single-bearing with SAE coupling disc.
IM 1001 (B 34) double-bearing with SAE flange and standard cylindrical shaft extension.
- Drip-proof machine, self-cooled
- Degree of protection: IP 23

2.1.1 - Mechanical options

- Air inlet filter
- Regreasable ball bearings
- IP 44 protection



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3 - INSTALLATION

Personnel undertaking the various operations indicated in this section must wear personal protective equipment appropriate for mechanical and electrical hazards.

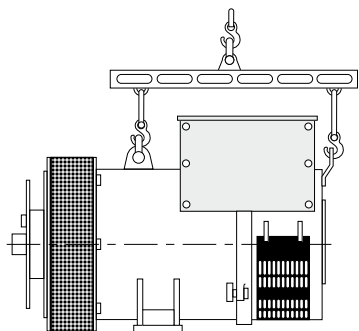
3.1 - Assembly



All mechanical handling operations must be undertaken using suitable equipment and the machine must be horizontal. Check how much the machine weighs (see 4.8.3.) before choosing the lifting tool.

3.1.1 - Handling

The generously-sized lifting rings are for handling the alternator alone. They must not be used to lift the genset. The choice of lifting hooks or handles should be determined by the shape of these rings. Choose a lifting system which respects the integrity and the environment of the alternators.



During this operation, do not allow anyone to stand under the load.

3.1.2 - Coupling

3.1.2.1 - Single-bearing alternator

Before coupling the machines, check that they are compatible by:

- undertaking a torsional analysis of the transmission,
- checking the dimensions of the flywheel and its housing, the flange, coupling discs and offset.

WARNING

When coupling the alternator to the prime mover, do not use the fan to turn the alternator or rotor.

The holes of the coupling discs should be aligned with the flywheel holes by cranking the engine.

Make sure the alternator is securely bedded in position during coupling.

Check that there is lateral play on the crankshaft.

3.1.2.2 - Double-bearing alternator

- Semi-flexible coupling

Careful alignment of the machines is recommended, checking that the lack of concentricity and parallelism of both parts of the coupling do not exceed 0.1 mm.

This alternator has been balanced with a 1/2 key.

3.1.3 - Location

The room where the alternator is placed must be ventilated to ensure that the ambient temperature cannot exceed the data on the nameplate.

3.2 - Checks prior to first use

3.2.1 - Electrical checks



Under no circumstances should an alternator, new or otherwise, be operated if the insulation is less than 1 megohm for the stator and 100,000 ohms for the other windings.

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There are 2 possible methods for restoring the above minimum values.

a) Dry out the machine for 24 hours in a drying oven at a temperature of 110 °C (without the regulator).

b) Blow hot air into the air intake, having made sure that the machine is rotating with the exciter field disconnected.

Note : Prolonged standstill: In order to avoid these problems, we recommend the use of space heaters, as well as turning over the machine from time to time. Space heaters are only really effective if they are working continuously while the machine is stopped.

WARNING

Ensure that the alternator has the degree of protection matching the defined environmental conditions.

3.2.2 - Mechanical checks

Before starting the machine for the first time, check that:

- all fixing bolts and screws are tight.
- the cooling air is drawn in freely.
- the protective grilles and housing are correctly in place.

- the standard direction of rotation is clockwise as seen from the shaft end (phase rotation in order 1 - 2 - 3).

For anti-clockwise rotation, swap 2 and 3.

- the winding connection corresponds to the site operating voltage (see section 3.3).

3.3 - Terminal connection diagrams

To modify the connection, change the position of the stator cables on the terminals. The winding code is specified on the nameplate.

3.3.1 - Terminal connection: 12 wire

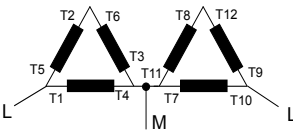
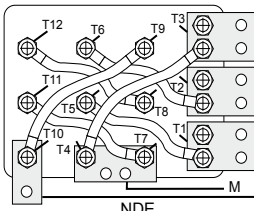

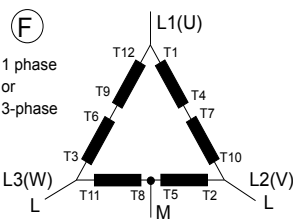
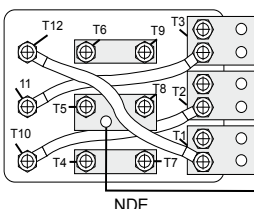

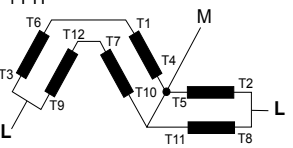
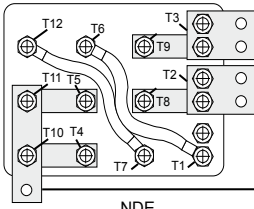


The connection accessories are detailed in section 5.3.3.



Any intervention on the alternator terminals during reconnection or checks should be performed with the machine stopped.

| Connection codes | | Voltage L-L | | Factory connection | |
|---|--|-------------|-----------|--------------------|--|
| <div><div>Ⓐ</div><div>3-phase</div><div></div></div> | Winding | 50 Hz | 60 Hz | <div></div> | |
| | 6 | 190 - 208 | 190 - 240 | | |
| | 7 | 220 | - | | |
| | 8 | - | 190 - 208 | | |
| | <div><div>⚠</div><div>R 250 voltage detection : 0 => (T8) / 110 V => (T11) R 450 voltage detection : 0 => (T3) / 220 V => (T2)</div></div> | | | | |
| <div><div>Ⓓ</div><div>3-phase</div><div></div></div> | Winding | 50 Hz | 60 Hz | <div></div> | |
| | 6 | 380 - 415 | 380 - 480 | | |
| | 7 | 440 | - | | |
| | 8 | - | 380 - 416 | | |
| | <div><div>⚠</div><div>R 250 voltage detection : 0 => (T8) / 110 V => (T11) R 450 voltage detection : 0 => (T3) / 380 V => (T2)</div></div> | | | | |
| 9 | 500 | 600 | | | |
| Winding 9 : R 450 voltage detection + transformer (See specific diagram AREP or SHUNT) | | | | | |
| <div><div>⚠</div><div>In case of reconnection, ensure that AVR voltage detection is correct ! The factory can supply a set of flexible shunts and special connection links as an option for making these connections. (*)</div></div> | | | | | |

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| Connection codes | Voltage L.L | | | Factory connection |
|---|-------------|-----------|-----------|--|
| (FF) 1 phase  Voltage LM = 1/2 voltage LL | Winding | 50 Hz | 60 Hz |  (*) |
| | 6 | 220 - 240 | 220 - 240 | |
| | 7 | 240 - 254 | - | |
| | 8 | - | 220 - 240 | |
|  R 250 voltage detection : 0 => (T4) / 110 V => (T1) R 450 voltage detection : 0 => (T10) / 220 V => (T1) | | | | |
| (F) 1 phase or 3-phase  Voltage LM = 1/2 voltage LL | Winding | 50 Hz | 60 Hz |  (*) |
| | 6 | 220 - 240 | 220 - 240 | |
| | 7 | 240 - 254 | - | |
| | 8 | - | 220 - 240 | |
|  R 250 voltage detection : 0 => (T8) / 110 V => (T11) R 450 voltage detection : 0 => (T3) / 220 V => (T2) Operating phases L2 (V), L3 (W) single phase | | | | |
| (G) 1 PH  Voltage LM = 1/2 voltage LL | Winding | 50 Hz | 60 Hz |  (*) |
| | 6 | 220 - 240 | 220 - 240 | |
| | 7 | 250 - 260 | - | |
| | 8 | 200 | 220 - 240 | |
|  R 250 voltage detection : 0 => (T8) / 110 V => (T11) R 450 voltage detection : 0 => (T3) / 220 V => (T2) | | | | |
|  In case of reconnection, ensure that AVR voltage detection is correct ! The factory can supply a set of flexible shunts and special connection links as an option for making these connections. (*). | | | | |

3.3.2 - Terminal connection: 6 wire (not possible with the R 250)

| <p>Connection codes</p> <p>(D) 3-phase</p> | <p>Voltage L.L</p> <table><tr><th>Winding</th><th>50 Hz</th><th>60 Hz</th></tr><tr><td>6S</td><td>380 - 415</td><td>380 - 480</td></tr><tr><td>7S</td><td>440</td><td>-</td></tr><tr><td>8S</td><td>-</td><td>380 - 416</td></tr><tr><td colspan="3"> R 450 voltage detection : 0 => (T3) / 380 V => (T2)</td></tr><tr><td>9S</td><td>-</td><td>600</td></tr></table> | Winding | 50 Hz | 60 Hz | 6S | 380 - 415 | 380 - 480 | 7S | 440 | - | 8S | - | 380 - 416 | R 450 voltage detection : 0 => (T3) / 380 V => (T2) | | | 9S | - | 600 | <p>Factory connection</p> <p>NDE Winding 9 : R 450 voltage detection + transformer (See specific diagram)</p> |
|--|--|-----------|-------|-------|----|-----------|-----------|----|-----------|---|----|---|-----------|--|--|--|-------------------|---|-----|--|
| Winding | 50 Hz | 60 Hz | | | | | | | | | | | | | | | | | | |
| 6S | 380 - 415 | 380 - 480 | | | | | | | | | | | | | | | | | | |
| 7S | 440 | - | | | | | | | | | | | | | | | | | | |
| 8S | - | 380 - 416 | | | | | | | | | | | | | | | | | | |
| R 450 voltage detection : 0 => (T3) / 380 V => (T2) | | | | | | | | | | | | | | | | | | | | |
| 9S | - | 600 | | | | | | | | | | | | | | | | | | |
| <p>(F) 1 phase or 3-phase</p> | <p>Voltage L.L</p> <table><tr><th>Winding</th><th>50 Hz</th><th>60 Hz</th></tr><tr><td>6S</td><td>220 - 240</td><td>220 - 277</td></tr><tr><td>7S</td><td>240 - 254</td><td>-</td></tr><tr><td>8S</td><td>-</td><td>220 - 240</td></tr><tr><td colspan="3"> R 450 voltage detection : 0 => (T3) / 220 V => (T2)</td></tr></table> <p>Operating phases : L2 (V), L3 (W) single phase</p> | Winding | 50 Hz | 60 Hz | 6S | 220 - 240 | 220 - 277 | 7S | 240 - 254 | - | 8S | - | 220 - 240 | R 450 voltage detection : 0 => (T3) / 220 V => (T2) | | | <p>(*)</p> | | | |
| Winding | 50 Hz | 60 Hz | | | | | | | | | | | | | | | | | | |
| 6S | 220 - 240 | 220 - 277 | | | | | | | | | | | | | | | | | | |
| 7S | 240 - 254 | - | | | | | | | | | | | | | | | | | | |
| 8S | - | 220 - 240 | | | | | | | | | | | | | | | | | | |
| R 450 voltage detection : 0 => (T3) / 220 V => (T2) | | | | | | | | | | | | | | | | | | | | |

In case of reconnection, ensure that the AVR voltage detection is correct !
The factory can supply a set of flexible shunts and special connection links as an option for making these connections. (*).

3.3.3 - Option connection diagram

| <p>R 791 T interference suppression kit (standard for CE marking)</p> <p>Connections</p> <table><tr><th></th><th>(A)</th><th>(D)</th><th>(F)</th></tr><tr><td>Black</td><td>T1</td><td>T1</td><td>T1</td></tr><tr><td>Black</td><td>T2</td><td>T2</td><td>T2</td></tr><tr><td>Black</td><td>T3</td><td>T3</td><td>T3</td></tr><tr><td>Blue</td><td>N</td><td>N</td><td>N</td></tr><tr><td>White</td><td></td><td></td><td></td></tr></table> | | (A) | (D) | (F) | Black | T1 | T1 | T1 | Black | T2 | T2 | T2 | Black | T3 | T3 | T3 | Blue | N | N | N | White | | | | <p>Remote voltage potentiometer</p> |
|--|---|---|-----|-----|-----------------|----|-----|-----------------|-------|-----|----------------------|----|-------|----|----|----|------|---|---|---|-------|--|--|--|--|
| | (A) | (D) | (F) | | | | | | | | | | | | | | | | | | | | | | |
| Black | T1 | T1 | T1 | | | | | | | | | | | | | | | | | | | | | | |
| Black | T2 | T2 | T2 | | | | | | | | | | | | | | | | | | | | | | |
| Black | T3 | T3 | T3 | | | | | | | | | | | | | | | | | | | | | | |
| Blue | N | N | N | | | | | | | | | | | | | | | | | | | | | | |
| White | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p>Current transformer connection (optional)</p> <p>Coupling D- PH 1 In - Secondary 1 A</p> | | <p>Coupling D & A- PH 1 In - Secondary 1A (coup. D)</p> | | | | | | | | | | | | | | | | | | | | | | | |
| <p>Anti condensation heater</p> | <p>Thermistor (PTC) temperature</p> <table><tr><td>103</td><td>Ph1</td><td>130 C blue wire</td></tr><tr><td></td><td>Ph2</td><td>150C black wire</td></tr><tr><td>104</td><td>Ph3</td><td>180 C red/white wire</td></tr></table> | | 103 | Ph1 | 130 C blue wire | | Ph2 | 150C black wire | 104 | Ph3 | 180 C red/white wire | | | | | | | | | | | | | | |
| 103 | Ph1 | 130 C blue wire | | | | | | | | | | | | | | | | | | | | | | | |
| | Ph2 | 150C black wire | | | | | | | | | | | | | | | | | | | | | | | |
| 104 | Ph3 | 180 C red/white wire | | | | | | | | | | | | | | | | | | | | | | | |

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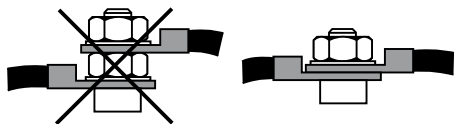
3.3.4 - Connection checks



Electrical installations must comply with the current legislation in force in the country of use.

Check that:

- The residual circuit-breaker conforms to legislation on protection of personnel, in force in the country of use, and has been correctly installed on the alternator power output as close as possible to the alternator. (In this case, disconnect the wire of the interference suppression module linking the neutral).
- Any protection devices in place have not been tripped.
- If there is an external AVR, the connections between the alternator and the cabinet are made in accordance with the connection diagram.
- There is no short-circuit phase-phase or phase-neutral between the alternator output terminals and the generator set control cabinet (part of the circuit not protected by circuitbreakers or relays in the cabinet).
- The machine should be connected with the busbar separating the terminals as shown in the terminal connection diagram.



3.4 - Commissioning



The machine can only be started up and used if the installation is in accordance with the regulations and instructions defined in this manual.

The machine is tested and set up at the factory. When first used with no load, make sure that the drive speed is correct and stable (see the nameplate). With the regreasable bearing option, we recommend greasing the bearings at the time of commissioning (see 4.2.3).

On application of the load, the machine should achieve its rated speed and voltage; however, in the event of abnormal operation, the machine setting can be altered (follow the adjustment procedure in section 3.5). If the machine still operates incorrectly, the cause of the malfunction must be located (see section 4.4).

3.5 - Setting up



The various adjustments during tests must be made by a qualified engineer.

Ensure that the drive speed specified on the nameplate is reached before commencing adjustment.

After operational testing, replace all access panels or covers.

The AVR is used to make any adjustments to the machine.

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4 - SERVICING - MAINTENANCE

4.1 - Safety measures

Servicing or troubleshooting must be carried out strictly in accordance with instructions so as to avoid the risk of accidents and to maintain the machine in its original state.



All such operations performed on the alternator should be undertaken by personnel trained in the commissioning, servicing and maintenance of electrical and mechanical components, who must wear personal protective equipment appropriate for mechanical and electrical hazards.

Before any intervention on the machine, ensure that it cannot be started by a manual or automatic system and that you have understood the operating principles of the system.

4.2 - Routine maintenance

4.2.1 - Checks after start-up

After approximately 20 hours of operation, check that all fixing screws on the machine are still tight, plus the general state of the machine and the various electrical connections in the installation.

4.2.2 - Bearings

As standard, the alternator is fitted with permanently greased bearings. As an option, they may be regreasable. It is advisable to lubricate the alternator during operation. Time intervals and quantity of grease are given in the table below.

| | | |
|---------------------|---------|---------|
| NDE/DE bearing | 6316 C3 | 6315 C3 |
| Quantity of grease | 33 g | 30 g |
| Regreasing interval | 4000 H | 4500 H |

Lubrication intervals are given for grease type: LITHIUM - standard - NLGI 3.

In the factory, the grease used for lubrication is: ESSO - Unirex N3.

Before using another grease, check for compatibility with the original one. Monitor the temperature rise in the bearings (see section 4.4).

4.2.3 - Electrical servicing

Commercially-available volatile degreasing agents can be used.

WARNING

Do not use: trichlorethylene, perchlorethylene, trichloroethane or any alkaline products.



These operations must be performed at a cleaning station, equipped with a vacuum system that collects and flushes out the products used.

The insulating components and the impregnation system are not at risk of damage from solvents. Avoid letting the cleaning product run into the slots.

Apply the product with a brush, sponging frequently to avoid accumulation in the housing. Dry the winding with a dry cloth. Let any traces evaporate before reassembling the machine.

4.2.4 - Mechanical servicing

WARNING

Cleaning the machine using water or a highpressure washer is strictly prohibited. Any problems arising from such treatment are not covered by our warranty.

Degreasing: Use a brush and detergent (suitable for paintwork).

Dusting: Use an air gun.

If the machine is fitted with air inlet and outlet filters, the maintenance personnel should clean them routinely at regular intervals. In the case of dry dust, the filter can be cleaned using compressed air and/or replaced if it is clogged.

After cleaning the alternator, it is essential to check the winding insulation (see sections 3.2 and 4.8).

4.3 - Fault detection

If, when commissioned, the alternator does not work normally, the source of the malfunction must be identified (see sections 4.4 and 4.5).

| | | |
|---|------------------------------|----------------------|
| LEROY-SOMER | Installation and maintenance | 3856 en - 2011.01/ h |
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4.4 - Mechanical defects

| Fault | | Action |
|----------------------|---|---|
| Bearing | Excessive temperature rise in one or both bearings (bearing temperature more than 80 °C) with or without abnormal bearing noise | <ul style="list-style-type: none"> - If the bearing has turned blue or if the grease has turned black, change the bearing - Bearing not fully locked (abnormal play in the bearing cage) - Check the end shield alignment (flange not properly fitted) |
| Abnormal temperature | Excessive temperature rise in the alternator housing (more than 40° C above the ambient temperature) | <ul style="list-style-type: none"> - Air flow (intake-outlet) partially clogged or hot air is being recycled from the alternator or engine - Alternator operating at too high a voltage (> 105% of Un on load) - Alternator overloaded |
| Vibration | Excessive vibration | <ul style="list-style-type: none"> - Misalignment (coupling) - Defective mounting or play in coupling - Rotor balancing fault (Engine - Alternator) |
| | Excessive vibration and humming noise coming from the machine | <ul style="list-style-type: none"> - Phase imbalance - Stator short-circuit |
| Abnormal noise | Alternator damaged by a significant impact, followed by humming and vibration | <ul style="list-style-type: none"> - System short-circuit - Mis-parallelism <p>Possible consequences:</p> <ul style="list-style-type: none"> - Broken or damaged coupling - Broken or bent shaft extension - Shifting and short-circuit of revolving field winding - Fan fractured or coming loose on shaft - Irreparable damage to rotating diodes, AVR, surge suppressor |

4.5 - Electrical faults

| Fault | Action | Effect | Check/Cause |
|---|--|---|--|
| No voltage at no load on start-up | Connect a new battery of 4 to 12 volts to terminals E- and E+, respecting the polarity, for 2 to 3 seconds | The alternator builds up and its voltage is still correct when the battery is removed | - Lack of residual magnetism |
| | | The alternator builds up but its voltage does not reach the rated value when the battery is removed | <ul style="list-style-type: none"> - Check the connection of the voltage reference to the AVR - Faulty diodes - Armature short-circuit |
| | | The alternator builds up but its voltage disappears when the battery is removed | <ul style="list-style-type: none"> - Faulty AVR - Field windings open circuit (check winding) - Revolving field coil open circuit (check the resistance) |
| Voltage too low | Check the drive speed | Correct speed | <ul style="list-style-type: none"> - Check the AVR connections (AVR may be faulty) - Field windings short-circuited - Rotating diodes burnt out - Revolving field coil short-circuited - Check the resistance |
| | | Speed too low | Increase the drive speed (do not touch the AVR voltage pot. (P2) before running at the correct speed) |
| Voltage too high | Adjust AVR voltage potentiometer | Adjustment ineffective | Faulty AVR |
| Voltage oscillations | Adjust the AVR stability potentiometer | If no effect: try normal or fast stability modes (ST2) | <ul style="list-style-type: none"> - Check the speed: possibility of cyclic irregularity - Loose connections - Faulty AVR - Speed too low when on load (or AVR LAM set too high) |
| Voltage correct at no load and too low when on load | Run at no load and check the voltage between E+ and E- on the AVR | Voltage between E+ and E- (DC) SHUNT / AREP / PMG < 10V | - Check the speed (or AVR LAM set too high) |
| | | Voltage between E+ and E- SHUNT / AREP / PMG > 15V | <ul style="list-style-type: none"> - Faulty rotating diodes - Short-circuit in the revolving field coil. Check the resistance. - Faulty exciter armature. Check the resistance. |
| Voltage disappears during operation | Check the AVR, the surge suppressor, the rotating diodes, and replace any defective components | The voltage does not return to the rated value | <ul style="list-style-type: none"> - Exciter winding open circuit - Faulty exciter armature - Faulty AVR - Revolving field coil open circuit or short-circuited |

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4.5.1 - Checking the winding

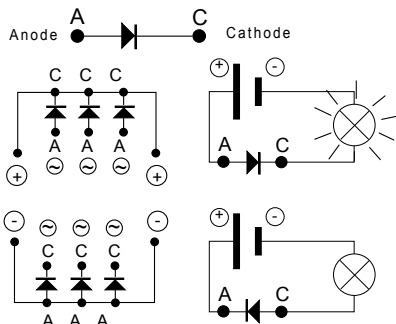
You can check the winding insulation by performing a high voltage test. In this case, you must disconnect all AVR wires.

WARNING

Damage caused to the AVR in such conditions is not covered by our warranty.

4.5.2 - Checking the diode bridge

A diode in good working order should allow the current to flow only in the anode-to-cathode direction.



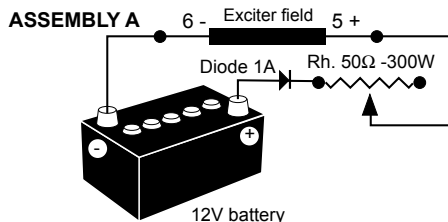
4.5.3 - Checking the windings and rotating diodes using separate excitation



During this procedure, make sure that the alternator is disconnected from any external load and inspect the terminal box to check that the connections are fully tightened.

- 1) Stop the unit, disconnect and isolate the AVR wires.
- 2) There are two ways of creating an assembly with separate excitation.

Assembly A: Connect a 12 V battery in series with a rheostat of approximately 50 ohms - 300 W and a diode on both exciter field wires (5+) and (6-).

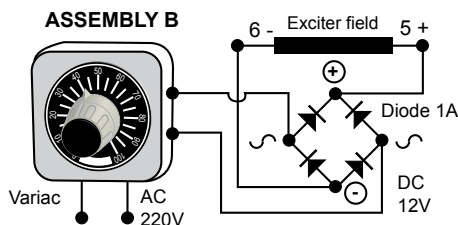


Assembly B: Connect a “Variac” variable power supply and a diode bridge on both exciter field wires (5+) and (6-).

Both these systems should have characteristics which are compatible with the field excitation power of the machine (see the nameplate).

3) Run the unit at its rated speed.

4) Gradually increase the exciter field current by adjusting the rheostat or the variac and measure the output voltages on L1 - L2 - L3, checking the excitation voltage and current at no load (see the machine nameplate or ask for the factory test report). When the output voltage is at its rated value and balanced within 1% for the rated excitation level, the machine is in good working order. The fault therefore comes from the AVR or its associated wiring (ie. sensing, auxiliary windings).



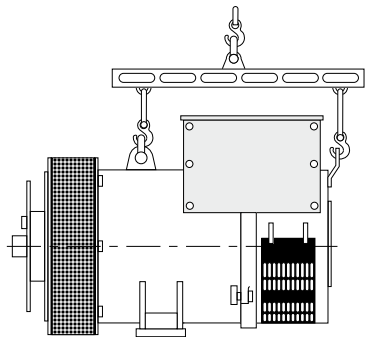
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4.6 - Dismantling, reassembly (see sections 5.4.1. & 5.4.2.)

WARNING

During the warranty period, this operation should only be carried out in an LEROY-SOMER approved workshop or in our factory, otherwise the warranty may be invalidated.

Whilst being handled, the machine should remain horizontal (rotor not locked in position). Check how much the machine weighs (see 4.8.3) before choosing the lifting method.



4.6.1 - Tools required

To fully dismantle the machine, we recommend using the tools listed below:

- 1 ratchet spanner + extension
- 1 torque wrench
- 1 set of flat spanners: 8 mm, 10 mm, 18 mm
- 1 socket set: 8, 10, 13, 16, 18, 21, 24, 30 mm
- 1 socket with male ferrule: 5 mm
- 1 puller

4.6.2 - Screw tightening torque

See section 5.4.

4.6.3 - Access to diodes

- Open the air intake grille (51).
- Disconnect the diodes.
- Check the 6 diodes, change the diode bridges if necessary.

4.6.4 - Access to connections and the regulation system

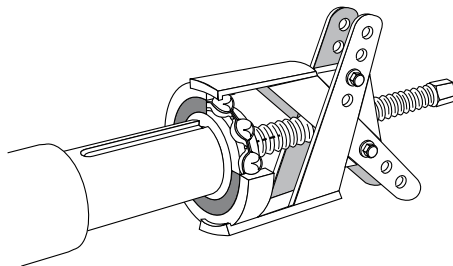
Access directly by removing the top of the cover (48) or the AVR access door (466).

4.6.5 - Replacing the NDE bearing

- Remove the box lid (48) and the NDE panel (365) and remove the 2 screws from the part (122).
- Disconnect the stator outputs (T1 to T12).
- Disconnect the auxiliary winding wires AREP (X1,X2,Z1,Z2).
- Disconnect the exciter wires (5+,6-).
- Remove the air inlet louvre (51).

If using a single-bearing or double-bearing machine with the regreasable bearing option:

- Remove the bearing (78) thrust screws (72).
- Remove all 4 screws (37).
- Remove the shield (36).
- Take out the antifriction bearing (70) using a puller with a central screw (see drawing below).



- Fit the new antifriction bearing onto the shaft after heating it by induction to approximately 80 °C.

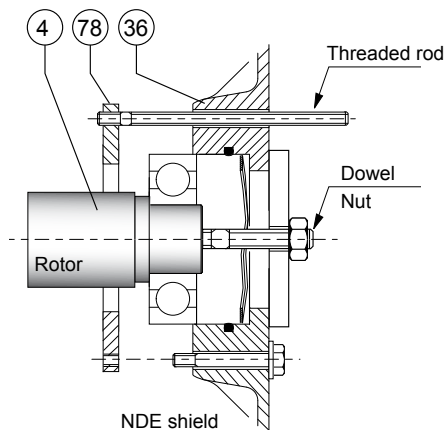
- Mount the new preloading (wavy) washer (79) + the new "O" ring seal (349) in the shield (36) and coat the bearing seat with adhesive paste (see After Sales Service).

If using a single-bearing or double-bearing machine with the regreasable bearing option:

- Screw a threaded rod into the thrust bearing (78).
- Refit the end shield on the machine using a dowel and nut in the shaft extension (see drawing).

LSA 46.2 - 4 POLES ALTERNATORS

- Slide the threaded rod into the shield hole to make it easier to assemble (see basic diagram).



- Fit the thrust bearing screws (78), remove the threaded rod, fit the other screw and tighten up the assembly.
- Tighten the 4 bearing screws (37).
- Reconnect wires.
- Fit the 2 support screws (122).
- Fit the air inlet louvre (51).
- Replace the cover.

WARNING

When dismantling the shields, you will need to change the antifriction bearings, the "O" ring seal, the preloading (wavy) washer and adhesive paste.

4.6.6 - Replacing the DE bearing

- Remove the air outlet grille (33).
- Remove the 6 screws (31) from the DE shield and the 3 screws (62) from the inner bearing retainer.
- Remove the shield (30).
- Take out the ball bearing (60) using a puller with a central screw (see section 4.6.5).
- Fit the new bearing, after heating it by induction to approximately 80 °C.
- Screw a threaded rod into the thrust bearing (68).
- Refit the shield (30) on the machine.

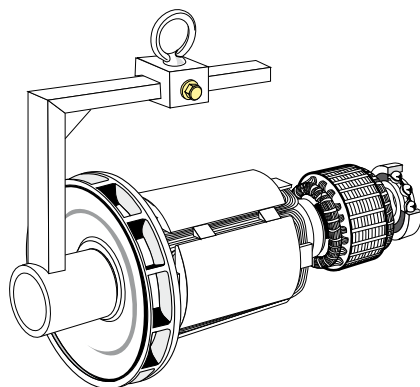
- Slide the threaded rod into the shield hole to make it easier to assemble (see basic diagram).

- Tighten the bottom thrust bearing screws (78), remove the threaded rod and fit the other screws.
- Tighten the 6 shield screws (31).
- Refit the air outlet grille (33).

4.6.7 - Dismantling the rotor assembly

- Remove the NDE shield (36) as described in section 4.6.5.
- Remove the DE shield (30) as described in section 4.6.6 if it is a double-bearing machine.
- Support the DE rotor (4) with a strap or with a support constructed in accordance with the following drawing.
- Move the strap as the rotor moves in order to distribute the weight over it.

WARNING



When dismantling the rotor involves changing parts or rewinding, the rotor must be rebalanced.

4.6.8 - Reassembling the machine

- Mount the rotor (4) in the stator (1) (see drawing above) taking care not to knock the windings.

LSA 46.2 - 4 POLES ALTERNATORS

If using a single-bearing or double-bearing machine with the regreasable bearing option:

- Mount the new preloading (wavy) washer (79) + the new "O" ring seal (349) in the shield (36).
- Screw a threaded rod into the thrust bearing (78).
- Refit the shield (36) on the machine using a dowel and nut in the shaft extension (see diagram).
- Slide the threaded rod into the shield hole to make it easier to assemble (see diagram).
- Fit the thrust bearing screws (78), remove the threaded rod, fit the other screw and tighten up the assembly.
- Tighten the 4 bearing screws (37).
- Reconnect exciter wires E+, E-.
- Finish reassembling the cover.
- Refit the flange (30) on the stator (1).
- Tighten the screws (31).

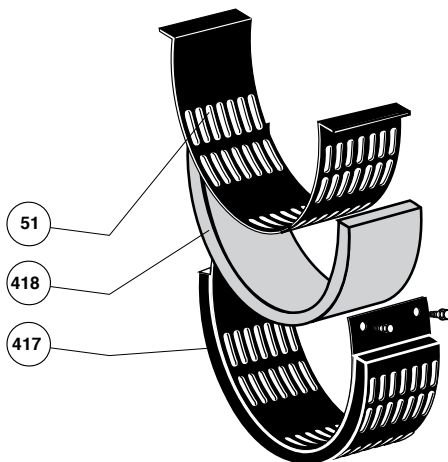
If using a double-bearing machine:

- Mount the new preloading (wavy) washer (79) + the new "O" ring seal (349) in the shield (36).
- Refit the shield (36) on the machine using a dowel and nut in the shaft extension (see diagram).
- Tighten the 4 shield screws (37).
- Reconnect exciter wires E+, E-.
- Finish reassembling the cover.
- Screw a threaded rod into the thrust bearing (68).
- Refit the shield (30) on the machine.
- Slide the threaded rod into the shield hole to make it easier to assemble (see basic diagram).
- Fit the thrust bearing screws (68), remove the threaded rod, fit the other screw and tighten up the assembly.
- Tighten the 6 shield screws (31).
- Refit the air outlet grille (33).
- Check that the machine assembly is correctly mounted and that all screws are tightened.

4.6.9 - Dismantling and reassembly of the filters

- Remove the grille (417) then take out the filter (418). Change the filter if necessary; please refer to section 4.2.5 for cleaning the filter.

To replace, follow the instructions in reverse order.



4.7 - Installation and maintenance of the PMG

For the LSA 46.2, the PMG reference is: PMG 2.

See the PMG manual ref : 4211.

LSA 46.2 - 4 POLES ALTERNATORS

4.8 - Table of characteristics

Table of average values

Alternator - 4 poles - 50 Hz - Standard winding No. 6.

(400V for the excitation values)

The voltage and current values are given for no-load operation and operation at rated load with separate field excitation.

All values are given to within $\pm 10\%$ and may be changed without prior notification (for exact values, consult the test report).

4.8.1 - LSA46.2 average values

Resistances at 20 °C (Ω)

| LSA 46.2 | Stator L/N | Rotor | Field | Armature |
|----------|------------|-------|-------|----------|
| M3 | 0.022 | 0.23 | 8.8 | 0.035 |
| M5 | 0.0182 | 0.24 | 8.8 | 0.035 |
| L6 | 0.0148 | 0.264 | 8.8 | 0.035 |
| L9 | 0.012 | 0.295 | 8.8 | 0.035 |
| VL12 | 0.0085 | 0.343 | 10 | 0.037 |

Resistance of AREP auxiliary windings at 20 °C (Ω)

| LSA 46.2 | Auxil wdg: X1, X2 | Auxil wdg: Z1, Z2 |
|----------|-------------------|-------------------|
| M3 | 0.24 | 0.4 |
| M5 | 0.215 | 0.36 |
| L6 | 0.185 | 0.36 |
| L9 | 0.19 | 0.32 |
| VL12 | 0.17 | 0.32 |

Field excitation current i_{exc} (A)

Symbols : "i exc": excitation current of the exciter field

| LSA 46.2 | No load | At rated load |
|----------|---------|---------------|
| M3 | 1.1 | 4 |
| M5 | 1.1 | 3.8 |
| L6 | 1.1 | 4.1 |
| L9 | 1.2 | 4 |
| VL12 | 1.1 | 3.5 |

For 60 Hz machines, the "i exc" values are approximately 5 to 10 % lower.

4.8.2 - Voltage of auxiliary windings at no load

| LSA 46.2 | Auxil wdg: X1, X2 | Auxil wdg: Z1, Z2 |
|----------|-------------------|-------------------|
| 50 Hz | 70 V | 10 V |
| 60 Hz | 85 V | 12 V |

4.8.3 - Table of weights

(values given for information only)

| LSA 46.2 | Total weight (kg) | Rotor (kg) |
|----------|-------------------|------------|
| M3 | 600 | 250 |
| M5 | 700 | 260 |
| L6 | 800 | 290 |
| L9 | 850 | 320 |
| VL12 | 1000 | 380 |



After operational testing, it is essential to replace all access panels or covers.

LSA 46.2 - 4 POLES ALTERNATORS

5 - SPARE PARTS

5.1 - First maintenance parts

Emergency repair kits are available as an option.

They contain the following items:

| | |
|----------------------------|-----------------------|
| Emergency kit SHUNT | ALT 472 KS 001 |
| AVR R 250 | - |
| Diode bridge assembly | - |
| Surge suppressor | - |

| | |
|---------------------------|-----------------------|
| Emergency kit AREP | ALT 461 KS 001 |
| AVR R 450 | - |
| Diode bridge assembly | - |
| Surge suppressor | - |

| | |
|---------------------------|-----------------------|
| Single-bearing kit | ALT 471 KB 002 |
| Non drive end bearing | - |
| «O» ring | - |
| Preloading (wavy) washer | - |

| | |
|---------------------------|-----------------------|
| Double-bearing kit | ALT 471 KB 001 |
| Non drive end bearing | - |
| Drive end bearing | - |
| «O» ring | - |
| Preloading (wavy) washer | - |

5.2 - Technical support service

Our technical support service will be pleased to provide any additional information you may require.

When ordering spare parts, you should indicate the complete machine type, its serial number and the information given on the nameplate.

Address your enquiry to your usual contact.

Part numbers should be identified from the exploded views and their description from the parts list.

Our extensive network of service centres can dispatch the necessary parts without delay.

To ensure correct operation and the safety of our machines, we recommend the use of original manufacturer spare parts.

In the event of failure to comply with this advice, the manufacturer cannot be held responsible for any damage.

5.3 - Accessories

5.3.1 - Space heater for use when stopped

The space heater must run as soon as the alternator stops. It is installed at the rear of the machine. Its standard power is 250W with 220V or 250W with 110V on request.



Warning: the power supply is present when the machine has stopped.

5.3.2 - Temperature sensors with thermistors (PTC)

These are thermistor triplets with a positive temperature coefficient installed in the stator winding (1 per phase). There can be a maximum of 2 triplets in the winding (at 2 levels: warning and trip) and 1 or 2 thermistors in the shields.

These sensors must be linked to adapted sensing relays (supplied optionally).

Cold resistance of cold thermistor sensors: 100 to 250 Ω per sensor.

5.3.3 - Connection accessories

- 6-wire machines : coupling (F)
- 12-wire machines : coupling (A), (F .F), (F)

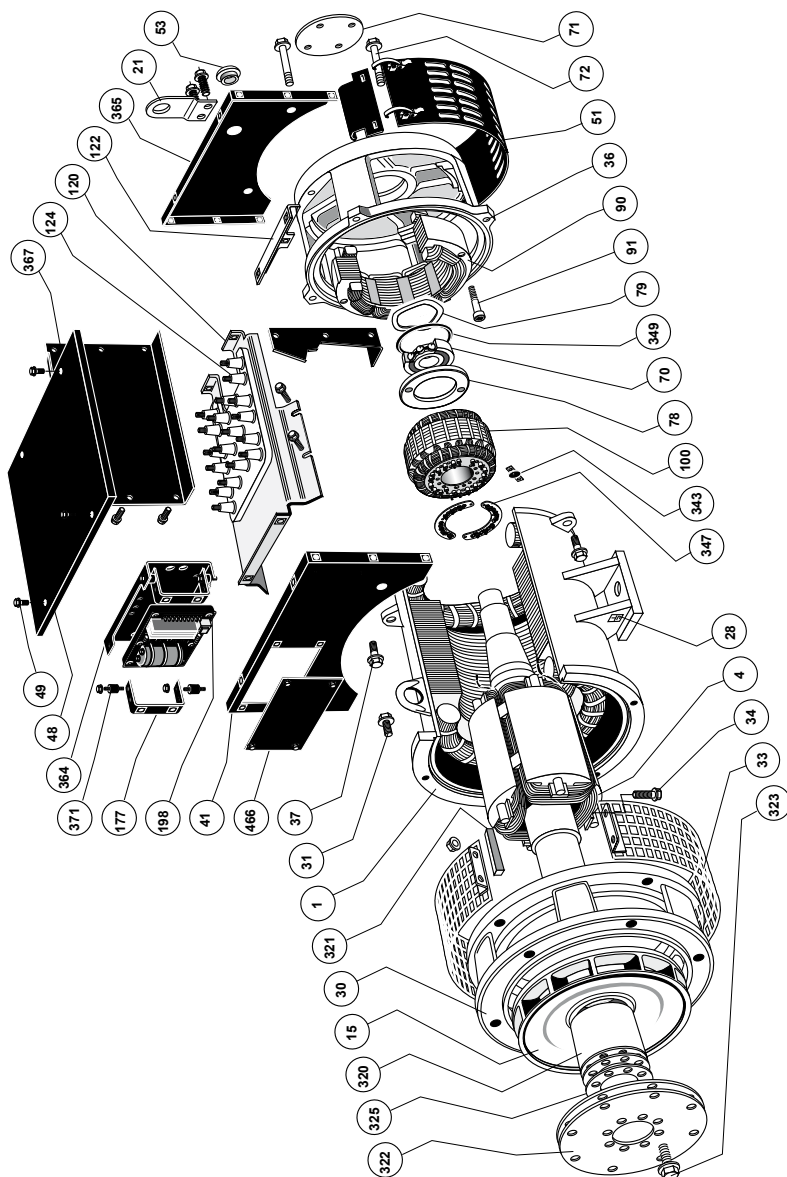


After operational testing, it is essential to replace all access panels or covers.

LSA 46.2 - 4 POLES ALTERNATORS

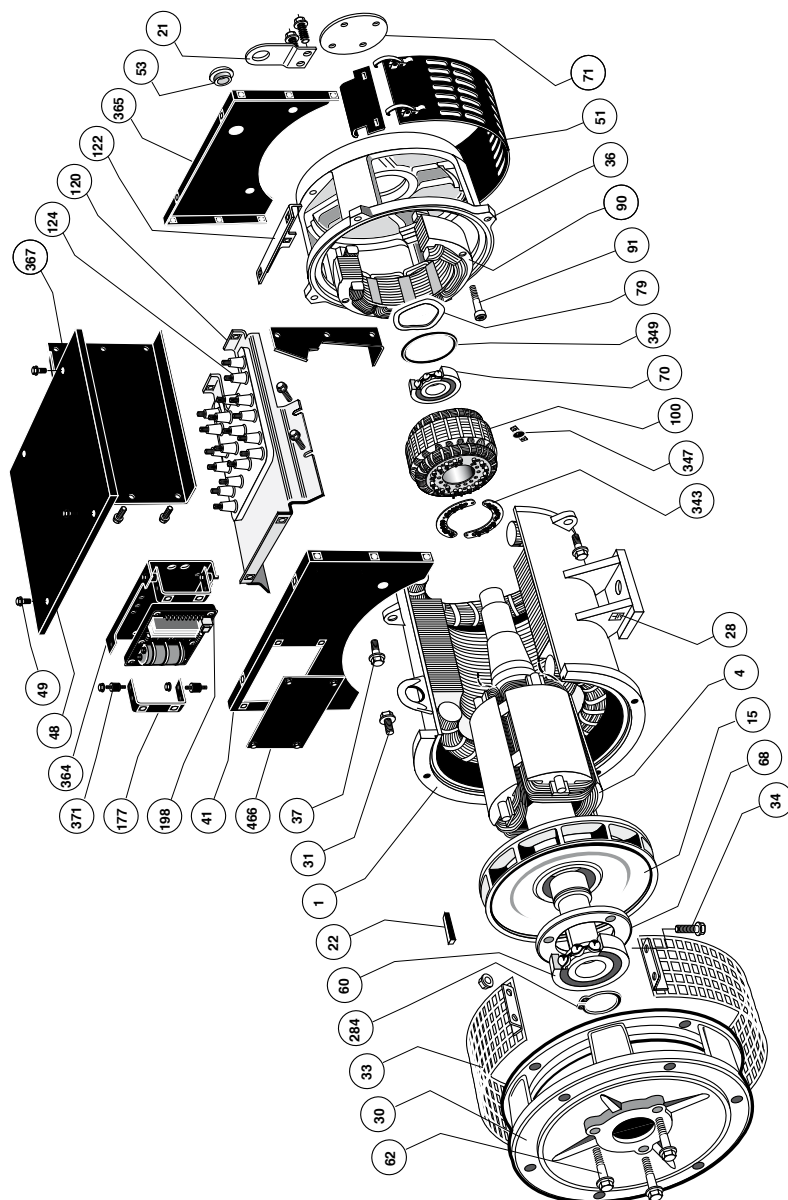
5.4 - Exploded view, parts list and tightening torque

5.4.1 - LSA 46.2 single-bearing



LSA 46.2 - 4 POLES ALTERNATORS

5.4.2 - LSA 46.2 double-bearing



| | | |
|---|------------------------------|----------------------|
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| LSA 46.2 - 4 POLES ALTERNATORS | | |

| Ref. | Qty | Description | Screw Ø | Torque N.m | Ref. | Qty | Description | Screw Ø | Torque N.m |
|------|--------|--------------------------|------------|---------------|------|-----|-----------------------------|------------|---------------|
| 1 | 1 | Stator assembly | - | - | 90 | 1 | Exciter field | - | - |
| 4 | 1 | Rotor assembly | - | - | 91 | 4 | Fixing screws | M6 | 10 |
| 15 | 1 | Fan | - | - | 100 | 1 | Exciter armature | - | - |
| 21 | 1 | Lifting ring | - | - | 120 | 1 | Terminal plate support | - | - |
| 22 | 1 | Shaft extension key | - | - | 122 | 1 | Plate support | - | - |
| 28 | 1 | Earth terminal | M10 | 20 | 124 | 1 | Terminal plate | M12 | 35 |
| 30 | 1 | Drive end shield | - | - | 177 | 2 | AVR support bracket | - | - |
| 31 | 6 or 4 | Fixing screws | M14 | 80(*) | 198 | 1 | Voltage regulator (AVR) | - | - |
| 33 | 1 | Protective grille | - | - | 284 | 1 | Circlips | - | - |
| 34 | 2 | Fixing screws | M6 | 5 | 320 | 1 | Coupling sleeve | - | - |
| 36 | 1 | Exciter end shield | - | - | 321 | 1 | Sleeve key | - | - |
| 37 | 4 | Fixing screws | M12 | 50 | 322 | 3 | Coupling disc | - | - |
| 41 | 1 | Cover front panel | - | - | 323 | 6 | Fixing screw | M16 | 230 |
| 48 | 1 | Cover top panel | - | - | 325 | - | Spacer shim | - | - |
| 49 | - | Cover screws | M6 | 5 | 343 | 1 | Diode bridge assembly | M6 | 4 |
| 51 | 1 | Air intake grille | - | - | 347 | 1 | Protection varistor (+ PCB) | - | - |
| 53 | 1 | Plug | - | - | 349 | 1 | "O" ring | - | - |
| 60 | 1 | Drive end bearing | - | - | 364 | 1 | AVR support | - | - |
| 62 | 3 or 4 | Fixing screws | M8 | 20 | 365 | 1 | Cover rear panel | - | - |
| 68 | 1 | Inner bearing retainer | - | - | 367 | 2 | Side panel | - | - |
| 70 | 1 | Non drive end bearing | - | - | 371 | 4 | Damper | - | - |
| 71 | 1 | Cover | - | - | 416 | 1 | Filter | - | - |
| 72 | 2 | Fixing screws | M8 | 20 | 417 | 1 | Filter support | - | - |
| 78 | 1 | Inner bearing retainer | - | - | 466 | 2 | AVR inspection door | - | - |
| 79 | 1 | Preloading (wavy) washer | - | - | | | | | |

(*) 80 N.m in M / 190 N.m in L, VL

| | | |
|---|------------------------------|----------------------|
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| LSA 46.2 - 4 POLES ALTERNATORS | | |

Electric Power Generation Division

Declaration of CE compliance and incorporation

This Declaration applies to the generators designed to be incorporated into machines complying with the Machinery Directive Nr 2006/42/CE dated 17 May 2006.

| | | |
|---|--|---|
| MOTEURS LEROY-SOMER Boulevard Marcellin Leroy 16015 ANGOULEME France | MLS HOLICE STLO.SRO SLADKOVSKÉHO 43 772 04 OLOMOUC Czech Republic | MOTEURS LEROY-SOMER 1, rue de la Burelle Boite Postale 1517 45800 St Jean de Braye France |
|---|--|---|

Declares hereby that the electric generators of the types LSA 36 – 37– 40 – 42.2 – 43.2 – 44.2 – 46.2 – 47.2 – 49.1 – 50.2 – 51.2, as well as their derivatives, manufactured by Leroy Somer or on Leroy Somer's behalf, comply with the following International Standards and Directive :

- EN and IEC 60034 -1 and 60034 -5
- ISO 8528 – 3 “ Reciprocating internal combustion engine driven alternating current generating sets.
Part 3. Alternating current generators for generating sets ”
- Low Voltage Directive Nr 2006/95/CE dated 12 December 2006.

Furthermore, these generators, designed in compliance with the Machine Directive Nr 2006/42, are therefore able to be incorporated into Electrical Gen-Sets complying with the following International Directives :

- Machinery Directive Nr 2006/42/CE dated 17 May 2006
- EMC Directive Nr 2004/108/CE dated 15 December 2004, as intrinsic levels of emissions and immunity are concerned

WARNING :

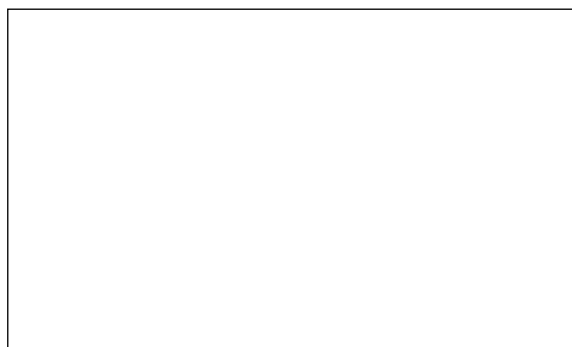
The here above mentioned generators should not be commissioned until the corresponding Gen-Sets have been declared in compliance with the Directives Nr 2006/42/CE et 2004/108/CE, as well as with the other relevant Directives.

Leroy Somer undertakes to transmit, in response to a reasoned request by the national authorities, relevant information on the generator.

Technical Managers
P Betge – J.Begué



| | | |
|---|------------------------------|----------------------|
| LEROY-SOMER | Installation and maintenance | 3856 en - 2011.01/ h |
| LSA 46.2 - 4 POLES ALTERNATORS | | |

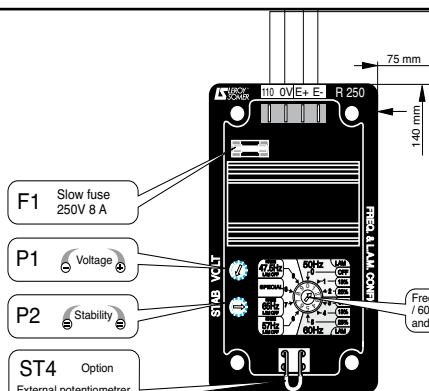


LEROY-SOMER 16015 ANGOULÊME CEDEX - FRANCE
338 567 258 RCS ANGOULÊME

www.leroy-somer.com



*This manual is to be given to
the end user*



R250 **A.V.R.**

Installation and maintenance

R250
A.V.R.

This manual concerns the alternator A.V.R. which you have just purchased.

We wish to draw your attention to the contents of this maintenance manual. By following certain important points during installation, use and servicing of your A.V.R., you can look forward to many years of trouble-free operation.

SAFETY MEASURES

Before using your machine for the first time, it is important to read the whole of this installation and maintenance manual.

All necessary operations and interventions on this machine must be performed by a qualified technician.

Our technical support service will be pleased to provide any additional information you may require.

The various operations described in this manual are accompanied by recommendations or symbols to alert the user to potential risks of accidents. It is vital that you understand and take notice of the following warning symbols.

WARNING

Warning symbol for an operation capable of damaging or destroying the machine or surrounding equipment.



Warning symbol for general danger to personnel.



Warning symbol for electrical danger to personnel.

Note : LEROY-SOMER reserves the right to modify the characteristics of its products at any time in order to incorporate the latest technological developments.

The information contained in this document may therefore be changed without notice.

| | | |
|------------------------|------------------------------|-----------------------|
| LEROY-SOMER | Installation and maintenance | 4067 en - 2009.05 / b |
| R250 A.V.R. | | |

SUMMARY

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Any maintenance or breakdown operations on the A.V.R. are to be done by personnel trained on commisioning, servicing and maintenance for the electrical and mechanical elements.

The R250 is an IP00 product. It must be installed inside a unit so that this unit's cover can provide IP20 minimum total protection (it must only be installed on LS alternators in the appropriate location so that when viewed externally, it has a higher degree of protection than IP20).

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R250

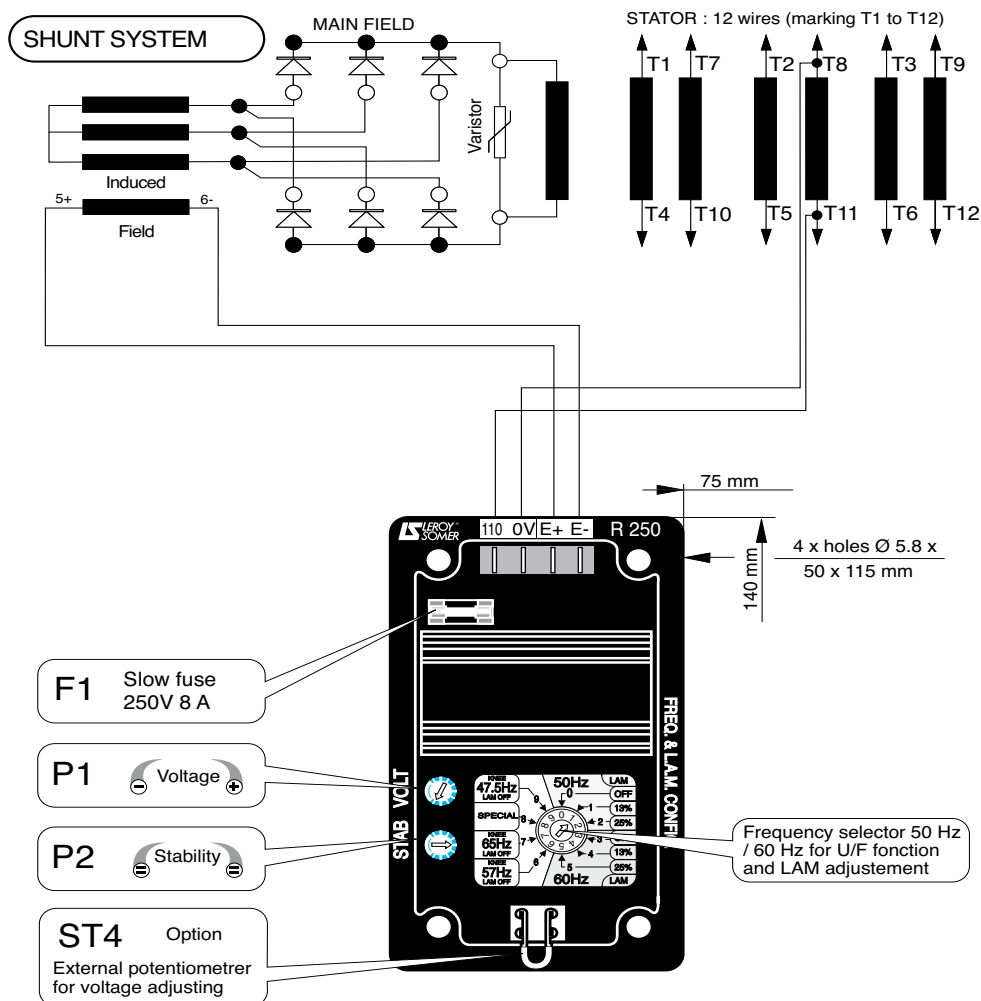
A.V.R.

1 - SUPPLY

1.1 - SHUNT excitation system

The SHUNT excitation alternator is auto-excited with a **R 250** voltage regulator.

The regulator controls the excitation current according to the alternator's output voltage. With a very simple conception, the SHUNT excitation alternator does not have a short circuit capacity.



R250 A.V.R.

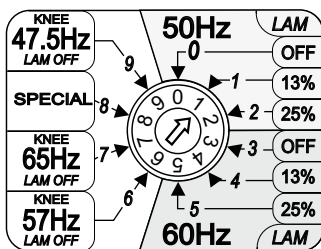
2 - R250 A.V.R.

2.1 - Characteristics

- Storage: -55°C; +85°C
- Operation: -40°C; +70°C
- Voltage regulation: around $\pm 0,5\%$.
- Supply range/voltage detection 85 to 139 V (50/60Hz).
- Rapid response time (500 ms) for a transient voltage variation amplitude of $\pm 20\%$.
- Voltage setting **P1**.
- Stability setting **P2**.
- Power supply protected by 8 A fuse, replacement product: Ferraz-Shawmut T084013T fast-blow fuse, 8 A FA 250 V, breaking capacity 30 kA.

2.2 - U/F Fonction and LAM

The threshold position (50 Hz - 60 Hz) to action the U/F fonction as well as the LAM setting type is selected using the potentiometer.



WARNING: The jumper settings must correspond to the rated operating frequency (see the nameplate on the alternator).

Risk of destruction for the alternator.

The threshold position and LAM fonction settings are done with the jumper.

Operating at 50 Hz: (U/F gradient)

0: threshold at 48 Hz without LAM for impacts between 30 and 40% of the rated load.

1: threshold at 48 Hz with LAM 13% for impacts between 40 and 70% of the rated load.

2: threshold at 48 Hz with LAM 25% for impacts > 70% of the rated load.

Operating at 60 Hz: (U/F gradient)

3: threshold at 58 Hz without LAM for impacts between 30 and 40% of the rated load.

4: threshold at 58 Hz with LAM 13% for impacts 40 and 70% of the rated load.

5: threshold at 58 Hz with LAM 25% for impacts > 70% of the rated load.

Specific operating

6: threshold at 57 Hz without LAM for speed variations at a steady state > 2 Hz

7: threshold at 65 Hz without LAM for variable speed and tractive / gearlec (U/F gradient).

8: special: the factory setting 48 Hz 2U/F gradient ; a special programme is possible on request. This programme must be specified before ordering, during the project study.

9: threshold at 47.5 Hz without LAM for speed variations at a steady state > 2 Hz. For hydraulic applications, it is advisable to select:

- position 0 for 50 Hz
- position 3 for 60 Hz

R250 A.V.R.

2.3 - R250 A.V.R. option

Potentiometer for voltage setting, 1000 W / 0,5 W min: setting range $\pm 5\%$.

- Remove the **ST4** jumper.



For wiring up the external potentiometer; the “earth” wires must be isolated as well as the potentiometer terminals (wires at the same voltage as the power).

2.4 - LAM characteristics (Load Acceptance Module)

2.4.1 - Voltage drop

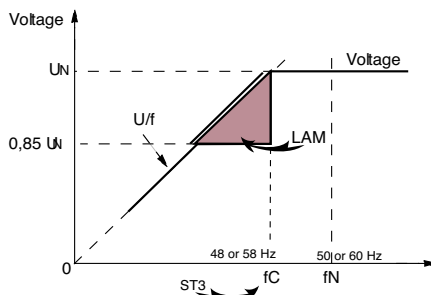
The LAM system is integrated in the A.V.R. It is active as standard. It can be adjusted to 13% or 25%.

- Role of the «LAM» (Load Adjustment Module):

On application of a load, the rotation speed of the generator set decreases. When it passes below the preset frequency threshold, the LAM causes the voltage to drop by approximately 13% or 25% and consequently the amount of active load applied is reduced by approximately 25% to 50%, until the speed reaches its rated value again.

Hence the “LAM” can be used either to reduce the speed variation (frequency) and its duration for a given applied load, or to increase the applied load possible for one speed variation (turbo-charged engines). To avoid voltage oscillations, the trip threshold for the “LAM” function should be set approximately 2 Hz below the lowest frequency in steady state.

It is advised to use the “LAM” at 25% for load impacts > at 70% of the genset rated power.

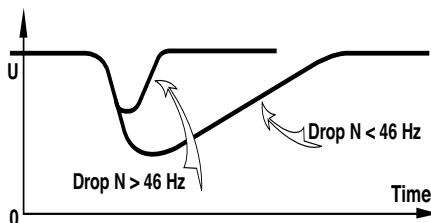


2.4.2 - Gradual voltage return function

During load impacts, the function helps the genset to return to its rated speed faster thanks to a gradual increase in voltage according to the following principles:

- if the speed drops between 46 Hz and 50 Hz, the rated voltage follows a fast gradient as it is restored.

- if the speed drops below 46 Hz, since the engine needs more help, the voltage follows a slow gradient as it returns to the reference value.

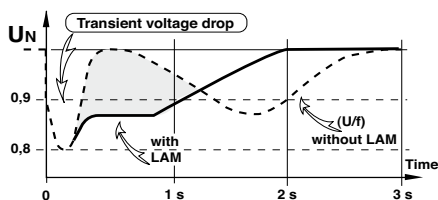


R250

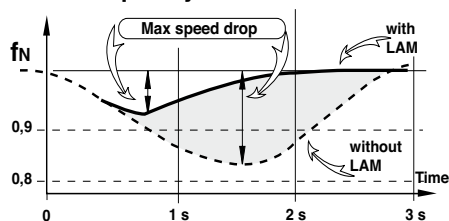
A.V.R.

2.5 - Typical effects of the LAM with a diesel engine or without a LAM (U/F only)

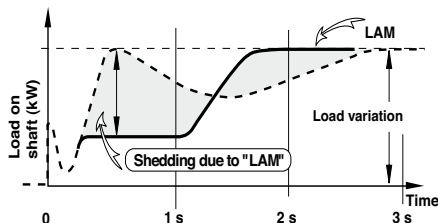
2.5.1 - Voltage



2.5.2 - Frequency



2.5.3 - Power



R250 A.V.R.

3 - INSTALLATION - COMMISSIONING

3.1 - Electrical checks on the AVR

- Check that all connections have been made properly as shown in the attached wiring diagram.
- Check that the position of the jumper corresponds to the operating frequency.
- Check whether the ST4 jumper or the remote adjustment potentiometer have been connected.

3.2 - Settings



The different settings made during the trial are to be done by qualified personnel. Respecting the load speed specified on the nameplate is vital in order to start a settings procedure. After operational testing, replace all access panels or covers. The only possible settings on the machine are to be done with the A.V.R.

3.2.1 - R250 settings (SHUNT system)

Initial potentiometer positions

- voltage setting potentiometer **P1** for the A.V.R.: full left
- remote voltage setting potentiometer: in the middle.

Operate the alternator at its rated speed: if the voltage does not rise it is necessary to re-magnetise the magnetic circuit.

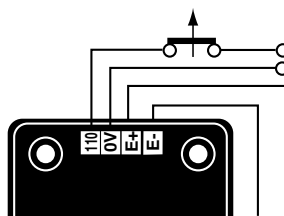
- slowly adjust the voltage potentiometer of the A.V.R. **P1** until the output voltage reaches its rated value.
- Stability setting with **P2**.

3.2.2 - Special type of use

WARNING

Excitation circuit E+, E- must not be left open when the machine is running: A.V.R. damage will occur.

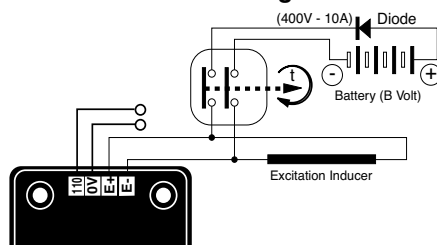
3.2.2.1 - R250 field weakening (SHUNT)



The exciter is switched off by disconnecting the A.V.R. power supply (1 wire - 0 or 110V). Contact rating: 16A - 250V AC

Do not reclose the power supply until the voltage has reached a value $\leq 15\%$ of the rated voltage (approximately 5 seconds after opening)

3.2.2.2 - R250 field forcing



The battery must be isolated from the mass.



Exciter field may be at line potential.

| | | |
|------------------------|------------------------------|-----------------------|
| LEROY-SOMER | Installation and maintenance | 4067 en - 2009.05 / b |
| R250 A.V.R. | | |

3.3 - Electrical faults

| Fault | Action | Effect | Check/cause |
|---|--|--|--|
| No voltage at no load on start-up | Connect a new battery of 4 to 12 volts to terminals E- and E+ respecting the polarity for 2 to 3 seconds | The alternator starts up and its voltage is still correct when the battery is removed. | - Lack of residual magnetism |
| | | The alternator starts up but its voltage does not reach the rated value when the battery is removed. | - Check the connection of the voltage reference to the A.V.R. - Faulty diodes - Induced short circuit |
| | | The alternator starts up but its voltage disappears when the battery is removed | - Faulty A.V.R. - Exciter field short-circuited - Short-circuit in the main field. Check the resistance |
| Voltage too low | Check the drive speed | Correct speed | Check the A.V.R. connections (A.V.R. may be faulty) - Field windings short-circuited - Rotating diodes burnt out - Main field winding short-circuited - Check the resistance |
| | | Speed too low | Increase the drive speed (Do not touch the A.V.R. pot (P1) before returning to the correct speed.) |
| Voltage too high | Adjust A.V.R. potentiometer | Adjustment ineffective | - Faulty A.V.R. - 1 faulty diode |
| Voltage oscillations | Adjust A.V.R. stability potentiometer | | - Check the speed: possibility of cyclic irregularity - Loose terminals - Faulty A.V.R. - Speed too low on load (or U/F gradient set too high) |
| Voltage correct at no load and too low when on load (*) | Run at no load and check the voltage between E+ and E- on the A.V.R. | | - Check the speed (or U/F gradient set too high) |
| | | | - Faulty rotating diodes - Short-circuit in the main field. Check the resistance - Faulty induced excitaion |
| (*) Warning: For single-phase operation, check that the sensing wires coming from the A.V.R. are correctly connected to the operating terminals (see the alternator manual). | | | |
| Voltage disappears during operation | Check the A.V.R., the surge suppressor, the rotating diodes and replace any defective components | The voltage does not return to the rated value | - Exciter winding open circuit - Faulty induced excitation - Faulty A.V.R. - Main field open circuit or short-circuited |



Warning: after setting-up or trouble-shooting, replace all access panels or covers.

R250
A.V.R.**4 - SPARE PARTS****4.1 - Designation**

| Description | Type | Code |
|-------------|-------|----------------|
| A.V.R. | R 250 | AEM 110 RE 019 |

4.2 - Technical support service

Our technical support service will be pleased to help you with any information needed.

For replacement part orders, it is necessary to indicate the type and the code number of the A.V.R.

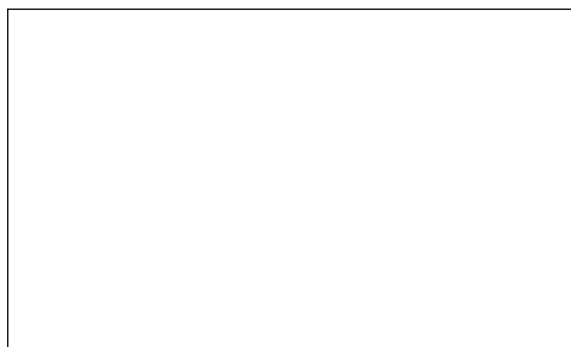
Please contact your usual correspondent.

An extensive network of service centres is available to rapidly supply any necessary parts.

In order to ensure the correct operation and safety of our machines, we strongly recommend that original manufacturer's spare parts are used.

Failure to do so, will discharge the manufacturer from liability in the case of damage.

R250
A.V.R.



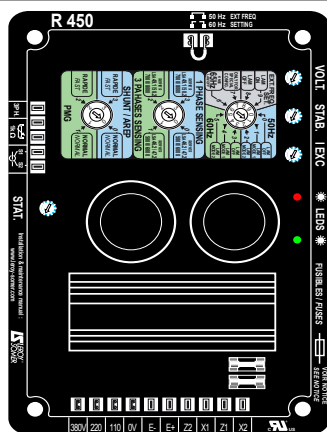
MOTEURS LEROY-SOMER 16015 ANGOULÊME CEDEX - FRANCE

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S.A. au capital de 62 779 000**

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This manual is to be given to
the end user



R 450 **AVRs**

Installation and maintenance

R 450 AVRs

This manual concerns the alternator AVR which you have just purchased.

We wish to draw your attention to the contents of this maintenance manual. By following certain important points during installation, use and servicing of your AVR, you can look forward to many years of trouble-free operation.

SAFETY MEASURES

Before using your machine for the first time, it is important to read the whole of this installation and maintenance manual.

All necessary operations and interventions on this machine must be performed by a qualified technician.

Our technical support service will be pleased to provide any additional information you may require.

The various interventions described in this manual are accompanied by recommendations or symbols to alert the user to potential risks of accidents. It is vital that you understand and take notice of the various warning symbols used.

WARNING

Warning symbol for an operation capable of damaging or destroying the machine or surrounding equipment.



Warning symbol for general danger to personnel.



Warning symbol for electrical danger to personnel.

Note: LEROY-SOMER reserves the right to modify the characteristics of its products at any time in order to incorporate the latest technological developments. The information contained in this document may therefore be changed without notice.

| | | |
|-----------------------------|------------------------------|-----------------------|
| LEROY-SOMER | Installation and maintenance | 4531 en - 2012.03 / e |
| R 450 AVRs | | |

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All servicing or repair operations performed on the AVR should be undertaken by personnel trained in the commissioning, servicing and maintenance of electrical and mechanical components.

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R 450

AVRs

1 - GENERAL INFORMATION

1.1 - Description

The R450 AVR is supplied in a casing designed to be mounted on a panel with dampers.

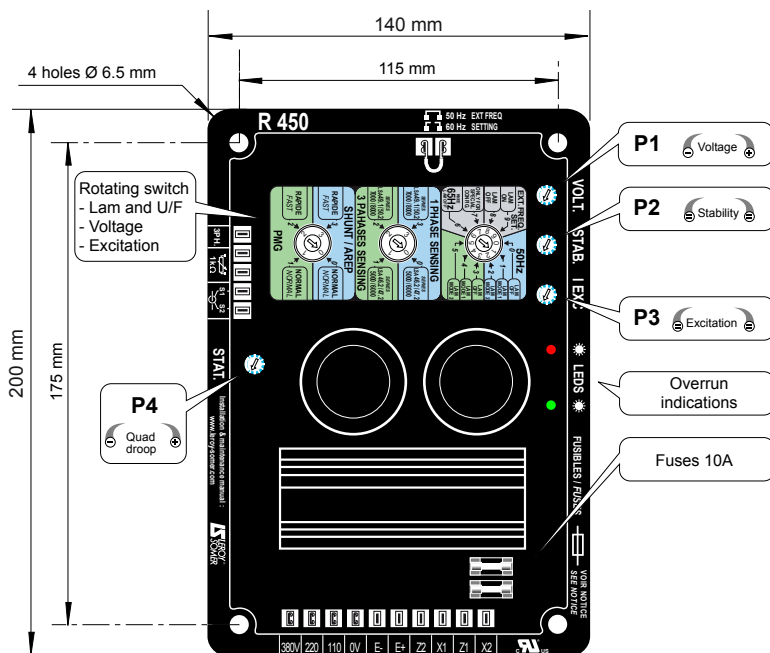
- Operating temperature: - 30°C to + 65° C.
- Storage temperature: - 55°C to + 85°C.
- Shocks on the base: 9 g depending on the 3 axes.
- Vibrations: less than 10 Hz, 2 mm half-peak amplitude 10 Hz to 100 Hz: 100 mm/s, above 100 Hz: 8 g.

WARNING

The AVR is IP00, it must be incorporated in an environment which ensures it a IP20 protection.

1.2 - Characteristic

The connection is realised by "Faston" connectors and the voltage sensing is single - phase.



R 450 AVRs

2 - POWER SUPPLY

Both the SHUNT/AREP & PMG excitation systems are controlled by the AVR.

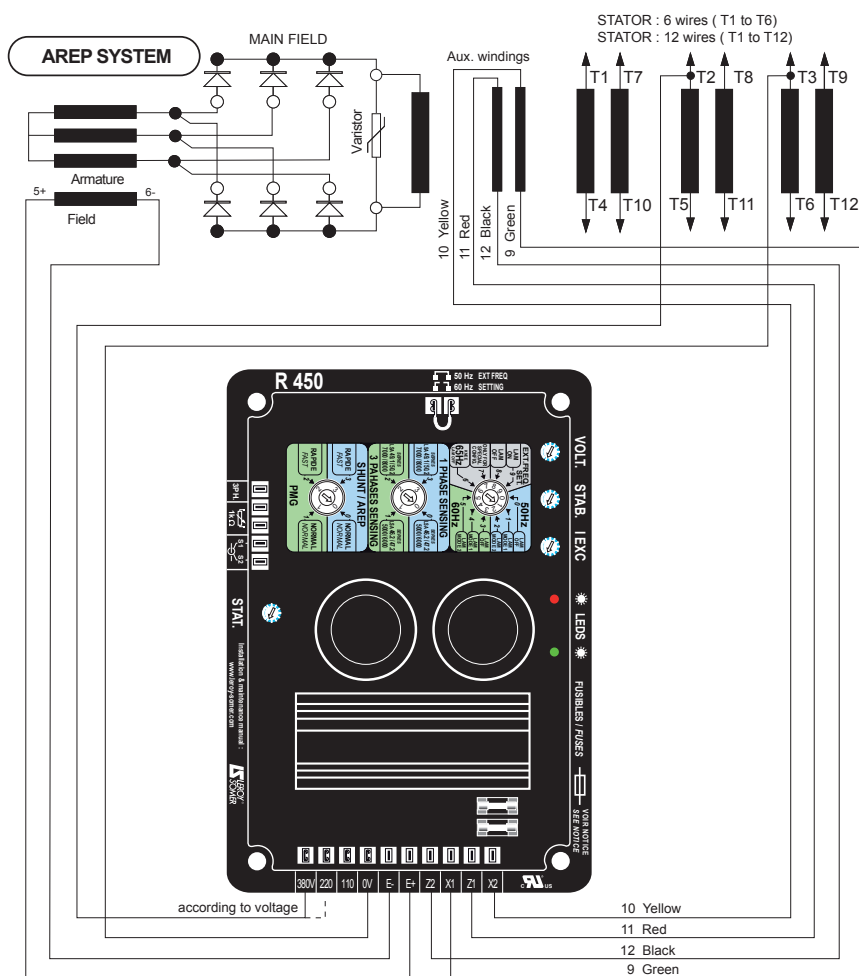
2.1 - AREP excitation system

With **AREP** excitation, the electronic AVR is powered by two auxiliary windings which are independent of the voltage sensing circuit.

The first winding has a voltage proportional to the alternator main voltage (Shunt

characteristic), the second one has a voltage proportional to the stator current (compound characteristic : Booster effect). The power supply voltage is rectified and filtered before being used by the AVR monitoring transistor.

This system provides the machine with a short-circuit current capacity of 3 IN for 10 s. The rotating switch should be in the AREP position (see 3.2.3).

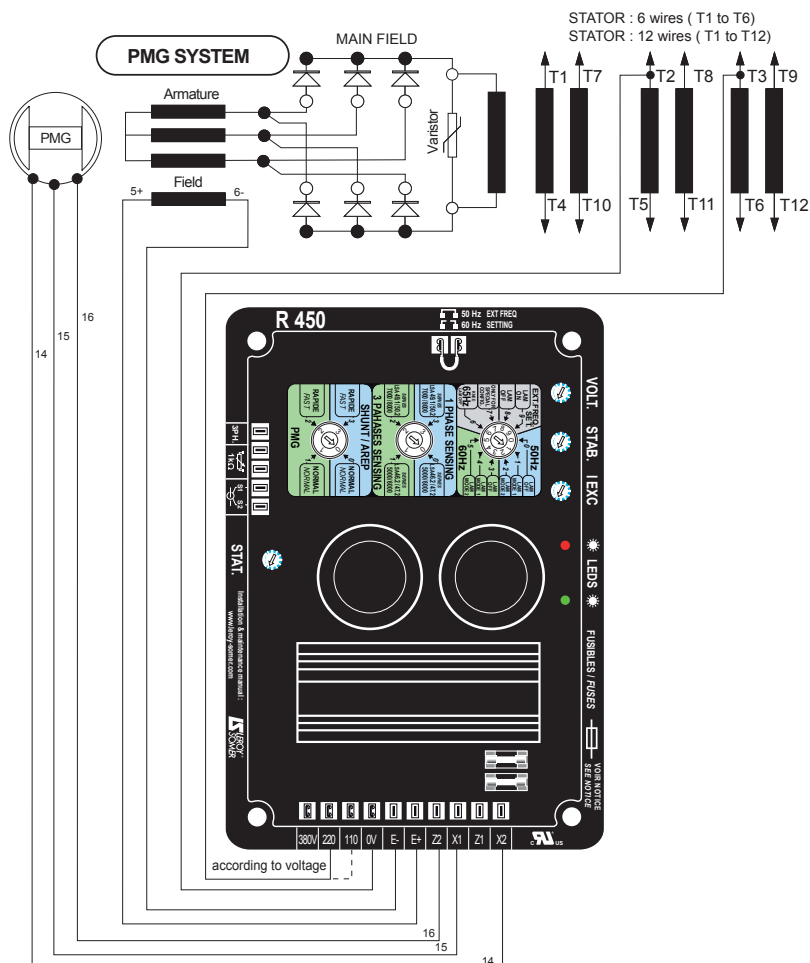


R 450 AVRs

2.2 - PMG excitation system

With **PMG** excitation, a permanent magnet generator (PMG) added to the alternator supplies the AVR with voltage which is independent of the main alternator winding. This system provides the machine with a short-circuit current capacity of 3 IN for 10 s.

The AVR monitors the alternator output voltage by adjusting the excitation current. The rotating switch should be in the PMG position (see 3.2.3).

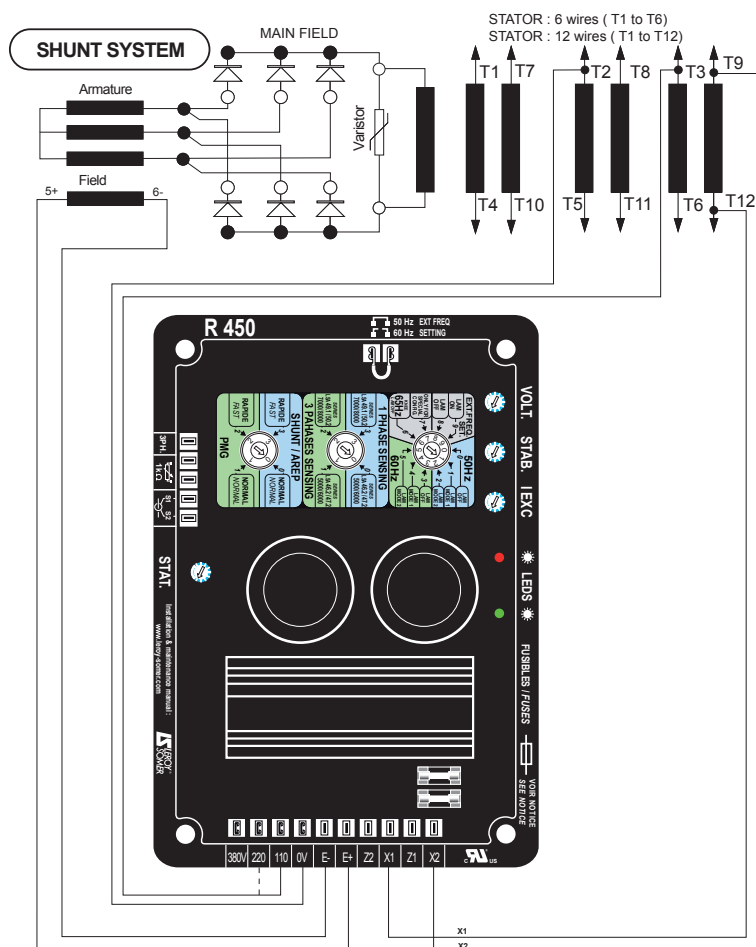


R 450 AVRs

2.3 - SHUNT or separate excitation system

With SHUNT excitation, the AVR is powered by the main winding (100V to 140V - 50/60 Hz) by using X1, X2 on the AVR.

The rotating switch should be in the SHUNT/AREP position (see 3.2.3).



R 450

AVRs

3 - TECHNICAL CHARACTERISTICS

3.1 - Electrical characteristics

- maximum power supply: 150V - 50/60 Hz
- Rated overload current: 10 A - 10 s
- Electronic protection:
 - In the case of a short-circuit, the excitation current is reduced to a value less than 1A after 10 s
 - In the event of loss of voltage reference, the excitation current is reduced to a value less than 1A after 1s for AREP/SHUNT, 10 s for PMG.
 - In the event of overexcitation, the current is reduced as indicated in the next diagram (see 3.2.1.4).
- Fuses: F1 on X1 and F2 on Z2 10A, 250V.
- Voltage sensing
 - 0-110 V terminals = 95 to 140 V
 - 0-220 V terminals = 170 to 260 V
 - 0-380 V terminals = 340 to 528 V

For other voltages, a transformer should be used.

- Voltage regulation: $\pm 0.5\%$.
- Current sensing: (parallel operation): input S1, S2 intended for 1 C.T. $< 2.5 \text{ VA cl1}$, secondary 1 A or 5 A.

3.2 - Configurations:

3.2.1 - Settings

3.2.1.1 - Voltage

Voltage adjustment via potentiometer **P1** in the ranges described in the table below:

| For 50 and 60 Hz | Max. |
|------------------|--|
| High range | $320\text{V} < U_n \leq 530 \text{ V}$ |
| Low range | $80 \text{ V} \leq U_n \leq 320 \text{ V}$ |

WARNING

The allowed adjustment range is $\pm 5\%$; when the setting exceeds these limits, please check that it is conform with the power table.

3.2.1.2 - Quadrature droop:

Quadrature droop adjustment via potentiometer **P4** within a range :

- from 0 to 8% with a PF=0.8 for 400V applications.
- From 0 to 14% with a PF=0.8 for 240V applications.
- From 0 to 8% for 110V applications with a step-up transformer (ratio of 4) placed on the voltage reference.

The potentiometer **P4** has a non linear response. Then, when a 1A secondary CT is connected the effective range starts from the the second 1/3 of **P4** range and in the case of a 5A secondary CT the effective range starts from the first 1/3.

When a 5ACT is used, the adjustment range is higher, so **P4** must be set to the first 1/4 (anti-clockwise) and then progressively increase it.

WARNING

The CT must be connected.

3.2.1.3 - Stability:

Stability adjustment via potentiometer **P2**. Selection of rotating switch according to the machine type and the response time as indicated in paragraph 3.2.3.

3.2.1.4 - Excitation limitation:

Excitation limitation adjustment via potentiometer **P3** as described below.

The excitation current limitation threshold in steady state is set by a potentiometer at 110% of the rated value. The adjustment is made by the operator during the on-load test at rated power by tuning the potentiometer. When the excitation current exceeds this value, a counter is activated at the speed of one record per second for 90 s. When this time is elapsed, the current is reduced to the value of the rated excitation current. If in the meantime the excitation current drops below the threshold value, the counter counts down at the same speed.

R 450 AVRs

WARNING

The limitation threshold must be adjustable between 1 and 5.5 A. The genset breaker must be open during the short circuit. If the genset is restarted in short circuit, there is a excitation build up during 10s again at the maximum value.

Operation between 3 and 6 In when short-circuited:

The excitation current ceiling during a short-circuit equals 2.9 times the fixed threshold when setting the permitted excitation ceiling in continuous operation. When the threshold is exceeded for a period = 10 s the current is reduced to a value between 0.5 and 0.7 A (shutdown). In all operating conditions the maximum

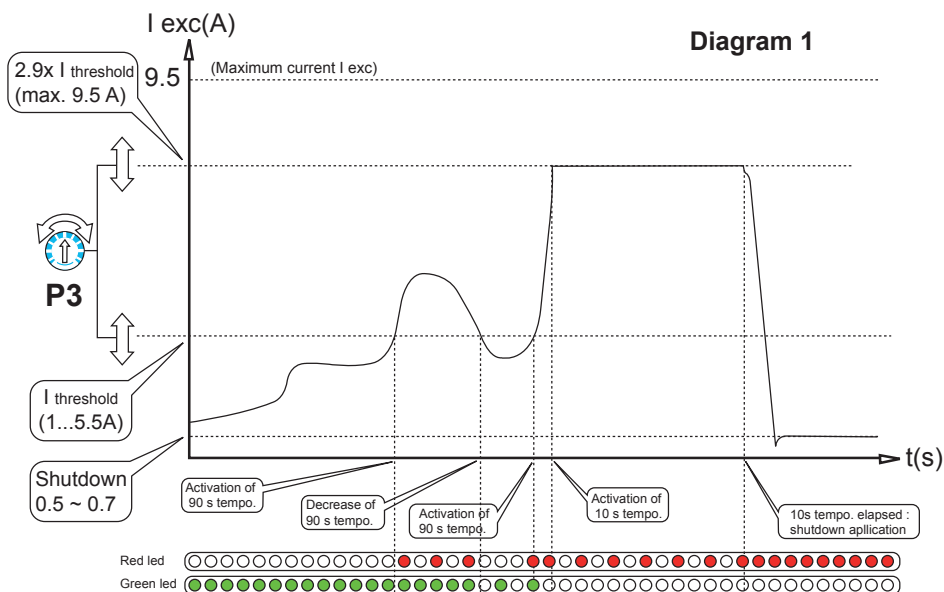
excitation current must be limited to $9\text{ A} \pm 0.5\text{ A}$.

Overrun indications:

One green LED:

- Lights up when the excitation current is below the continuous operation threshold. It signals the AVR normal operation.
- Turns off when the excitation current ceiling used to obtain short-circuit operation is reached and when the excitation current is reduced to the shutdown value.
- Flashes when the over excitation counter is decrementing.

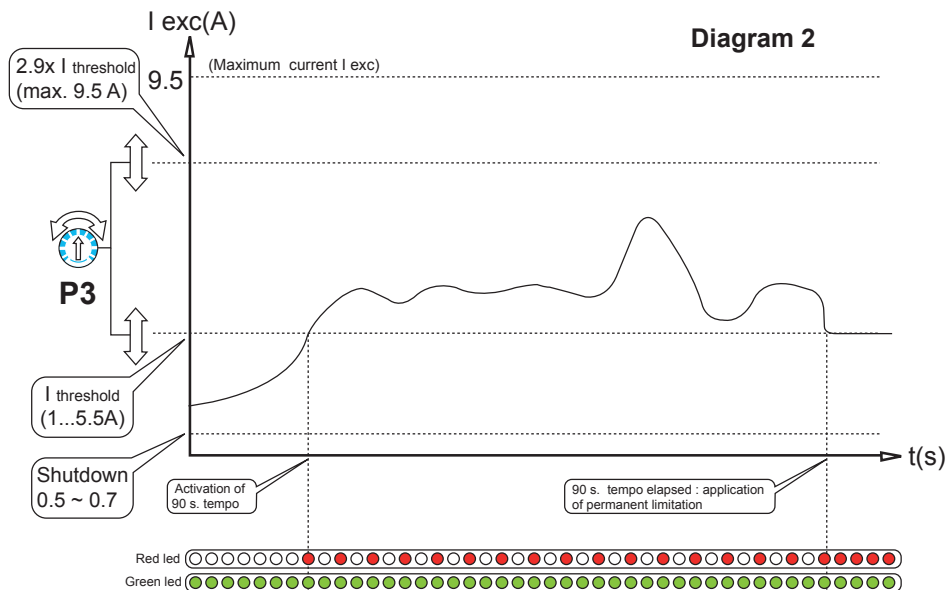
NB: After an obvious short-circuit, the voltage is limited to 70% of the rated voltage. This avoids overvoltages on machines whose no-load excitation current is below the "lower current" threshold (only in AREP).



R 450

AVRs

Diagram 2



One red LED:

- Lights up simultaneously with the green led when the continuous operation threshold is reached for more than 90 s and the excitation current is reduced to the continuous operation threshold. It is used to set the excitation current ceiling
- Turns off when the excitation current is less than the setting value ($< 110\% I_n$)
- Flashes when the excitation current is above the continuous operation threshold during less than 90 s.

Green LED stays on,

- flashes when the excitation current has reached the ceiling in $< 10s$ with PMG excitation.
- stays on if $I_{exc} = I_{Shutdown}$.

WARNING

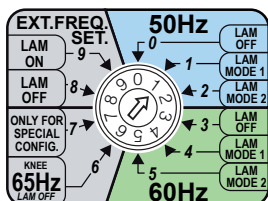
If the overload protection is activated, a voltage drop possibly exceeding 10% of the reference voltage will be observed.

The AVR does not provide undervoltage protection. The customer will need to make sure that their installation is correctly protected against undervoltages.

During load shedding, an overvoltage is observed, which will disappear in a few seconds.

R 450 AVRs

3.2.2 - Rotating switch selection: LAM and U/F

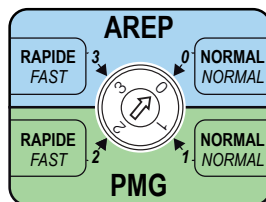


- **Pos 0:** Change in the voltage according to the U/F ratio, knee-point position at 48 Hz.
- **Pos 1:** Change in the voltage according to the 2U/F, knee-point position at 48 Hz.
- **Pos 2:** Change in the voltage according to the self auto-adaptating LAM combined with 2U/F, knee-point position at 48 Hz.
- **Pos 3:** Change in the voltage according to the U/F ratio, knee-point position at 58 Hz
- **Pos 4:** Change in the voltage according to the 2U/F, knee-point position at 58 Hz.
- **Pos 5:** Change in the voltage according to the self auto-adaptating LAM combined with 2U/F, knee-point position at 58 Hz.
- **Pos 6:** Change in the voltage according to the U/F ratio, knee-point position at 65 Hz (Tractelec application and variable speed above 1800 rpm).
- **Pos 7:** Special (not used).
- **Pos 8:** Change in the voltage according to the U/F ratio, knee-point position at 48 Hz or 58 Hz according to selection of the frequency by an external contact.
- **Pos 9:** Change in the voltage according to LAM 1, knee-point position at 48 Hz or 58 Hz according to selection of the frequency by an external contact

WARNING

For Pavers and hydraulic applications, select positions 0 (50 Hz) or 3 (60 Hz).

3.2.3 Rotating switch: excitation type and time response



0: AREP excitation and normal time response.

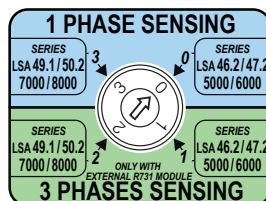
3: AREP excitation and fast time response.

1: PMG excitation and normal time response.

2: PMG excitation and fast time response.

For SHUNT applications, AREP excitation must be selected.

3.2.4 Rotating switch: voltage sensing



0: Single phase sensing

- LSA46.2/47.2 series.

3: Single phase sensing

- LSA49.1/50.2 series.

1: Three-phase sensing with optional module R731

- LSA46.2/47.2 series.

2: Three-phase sensing with optional module R731

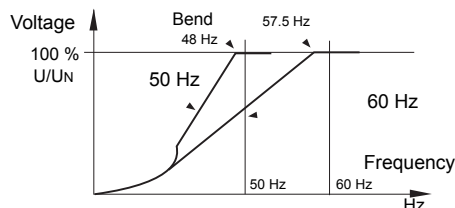
- LSA49.1/50.2 series.

R 450

AVRs

3.3 - U/F and LAM function

3.3.1 - Frequency variation compared with voltage (without LAM)



3.3.2 - LAM (Load Acceptance Module) characteristics

3.3.2.1 - Voltage drop

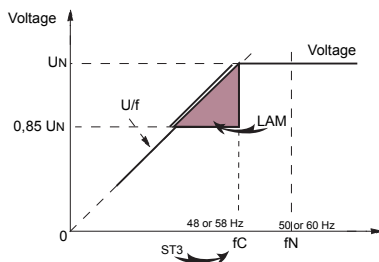
The LAM system is integrated in the AVR. As standard it is active.

Role of the LAM:

On application of a load, the genset rotation speed decreases. When it falls below the preset frequency threshold, the LAM causes the voltage to drop proportionately to the frequency (LAM1) or to the active power (LAM2) depending on the rotating switch position. This reduces the active load scale applied until the speed returns to its rated value.

Hence the LAM can be used either to reduce the speed variation (frequency) and its duration for a given applied load, or to increase the applied load possible for one speed variation (turbo-charged engine).

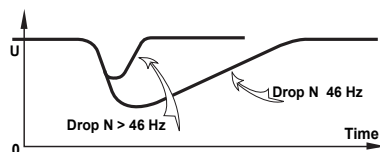
To avoid voltage oscillations, the trip threshold for the LAM function should be set approximately 2 Hz below the rated frequency.



3.3.2.2 - Soft voltage recovery function

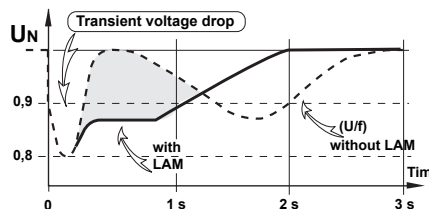
During load impacts, the function helps the genset to return to its rated speed faster with a gradual increase in voltage according to the principle:

- If the speed drops between 46 and 50 Hz (in 50Hz operation), the rated voltage is recovered by following a fast gradient.
- If the speed drops below 46 Hz, since the engine needs more help, the voltage follows a slow gradient as it returns to the reference value.

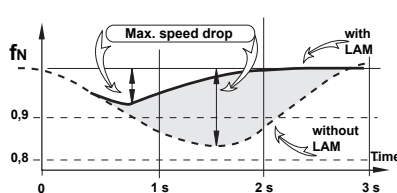


3.4 - Typical effects of the LAM with a diesel engine with or without a LAM (U/F only)

3.4.1 - Voltage

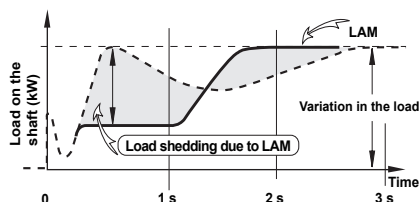


3.4.2 - Frequency



R 450 AVRs

3.4.3 - Power



- Equalization of voltages before paralleling (3 F).
- Possibility of coupling to the mains of alternators already running in parallel (4F).

- **R729 module:** same as R726 with additional functions.

- Detection of a diode fault.
- 4-20 mA input.
- Possibility of kVAR regulation.

3.5 - AVR options

- **Current transformer** for parallel operation of...../1 A or 5 A according to the potentiometer P4 position.

- **Voltage transformer** (adaptation)

- **Remote voltage adjustment potentiometer.**

For a range of variation:

$\pm 5\%$: 470 Ω

$\pm 10\%$: 1 k Ω

the power of the potentiometer can be 0.5 W, 2 W or 3 W.



The potentiometer input must be isolated. Do not connect it to the ground.

- **R 731 module:** 3-phase voltage sensing 200 to 500 V, compatible with parallel operation in balanced installations.

- **R 734 module:** 3-phase current and voltage sensing for parallel operation on unbalanced installations (unbalance > 15%).

- **R 726 module:** regulation system changed to "4 - function" (see the maintenance manual and connection diagram).

- PF regulation (2F) .

- **Voltage control:** with an **isolated** D.C. current source applied to the terminals used for the external potentiometer:

- Internal impedance 1.5 k Ω .
- A variation of ± 0.5 V corresponds to a voltage adjustment of $\pm 10\%$.

4-INSTALLATION-COMMISSIONING

4.1 - Electrical checks on the AVR

- Check that all connections have been made properly as shown in the attached wiring diagram.
- Check the rotating switches selections
 - frequency,
 - type of alternator,
 - normal position (response time),
 - external potentiometer,
 - rated voltage,
 - secondary current of the CT used,
 - type of excitation.
- R450 optional operating modes

| Action | Factory setting | Pot. |
|--|--------------------------------|------|
| Voltage minimum fully anti-clockwise | 400 V - 50 Hz | |
| Stability | Not set (centre position) | |
| Excitation ceiling - Factory-sealed | 10 A maximum | |
| Voltage quadrature droop (// operation with C.T.) - 0 quadrature droop fully anti-clockwise | Not set (fully anti-clockwise) | |

4.2 - Setting up



The various adjustments during tests must be made by a qualified engineer. It is essential that the drive speed specified on the nameplate is reached before commencing adjustment. After operational testing, replace all access panels or covers.

The AVR is used to make any adjustments to the machine.

4.2.1 - Setting up the R450

Before using the AVR, make sure that the rotating switches have been correctly configured with AREP/SHUNT or PMG excitation

a) Initial potentiometer settings (see table below)

Stability adjustments in standalone operation

b) Install a D.C. analogue voltmeter (needle dial) cal. 100 V on terminals F+, F- and an A.C. voltmeter cal. 300 - 500 or 1000 V on the alternator output terminals.

c) Check the rotating switch selection.

d) Voltage potentiometer P1 at minimum, fully anti-clockwise.

e) Stability potentiometer P2 around 1/3 in from the anti-clockwise stop.

f) Start the engine and set its speed to a frequency of 48 Hz for 50 Hz, or 58 for 60 Hz.

g) Set the output voltage to the desired value using P1.

- Rated voltage U_N for solo operation (eg. 400 V)
- Or $U_N + 2$ to 4% for parallel operation with C.T. (eg. 410 V -)

If the voltage oscillates, use P2 to make adjustments (try both directions), observing the voltage between F+ and F- (approx. 10 V D.C.). The best response time is obtained at the limit of the instability. If no stable position can be obtained, try selecting the fast position.

h) Check LAM operation: depending on the rotating switch selection.

R 450 AVRs

i) Vary the frequency (speed) around 48 or 58 Hz according to the operating frequency, and check the change in voltage from that observed previously (~ 15%).

j) Readjust the speed of the genset to its rated no-load value.

Adjustments in parallel operation

Before starting work on the alternator, make sure that the speed droop is identical for all engines.

k) Preset for parallel operation (with C.T. connected to S1, S2)

- Potentiometer **P4** (quadrature droop) in 1/4 position in the case of 5A CT and at 1/2 position in the case of 1A CT.

Apply the rated load (PF = 0.8 inductive). The voltage should drop by 2 to 3% (400 V). If it increases, check that neither V and W nor S1 and S2 have been reversed.

l) The no-load voltages should be identical for all the alternators intended to run in parallel.

- Couple the machines in parallel.
- By adjusting the speed, try to obtain 0 kW power exchange.

- By altering the voltage setting P1 on one of the machines, try to cancel (or minimise) the current circulating between the machines.
- From now on, do not touch the voltage settings.

m) Apply the available load (the setting is only correct if a reactive load is available)

- By altering the speed, match the kW (or divide the rated power of the units proportionally)

- By altering the quadrature droop potentiometer **P4**, match or divide the currents.

4.2.2 - Max. excitation adjustment (excitation ceiling)

In standard setting, the potentiometer P3 is in maximum position.

However, for applications requiring an overload protection (see 3.2.1.4), the excitation ceiling must be adjusted by using the following procedures in AREP and PMG.

Method 1 :

- Connect the AVR to the alternator
- apply load to 110% of rated machine rated at PF=0.8, the green led is on and the red one is off.

- record the excitation current value
- adjust P3 until obtaining the red led flashing, the green one is always on.

- decrease the load to 100% and make sure that the red led is off.

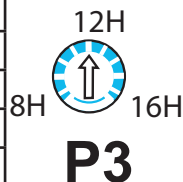
- Increase the load at 115%, check that the red LED flashes during 90 seconds and that the excitation current is brought back to the above adjusted value ($I_{\text{exc adjusted}}$).

Method 2 :

The rated excitation current (see machine plate) must be multiplied by 1.1 and the obtained value is used to set the potentiometer P3 at the right position.

The following table must be used.

| Position of P3 | I exc (A) |
|----------------|-----------|
| 8h | 1 |
| 9h | 1.55 |
| 10h | 1.95 |
| 11h | 2.5 |
| 12h | 3.15 |
| 13h | 3.65 |
| 14h | 4.25 |
| 15h | 4.7 |
| 16h | 5.15 |



NB: In the case of a permanent short-circuit, the excitation current must reach $2.9 \times I_{\text{exc adjusted}}$ (limited to 9.5A), during 1 second in AREP or 10 seconds in PMG and shuts down to a value less than 1A.

R 450 AVRs



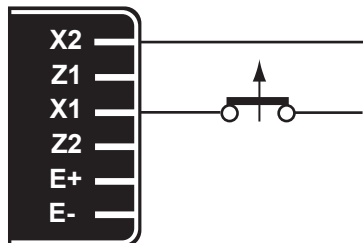
When the excitation current is set to the rated value, a voltage dip is observed in excitation current limit when the limitation is activated and the current limit is reached.

4.2.3 - Special type of use

WARNING

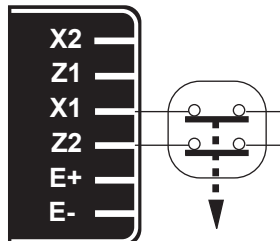
The excitation circuit F+, F- must not be left open when the machine is running: this will irreparably damage the AVR.

4.2.3.1 - R450 (SHUNT) field weakening



The exciter is switched off by disconnecting the AVR power supply (1 wire - X1 or X2)
Contact rating: 16 A - 250 V A.C.

4.2.3.2 - R450 (AREP/PMG) field weakening



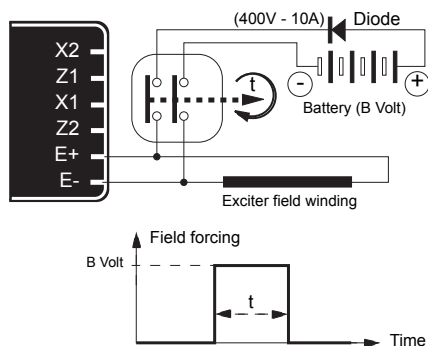
The exciter is switched off by disconnecting the AVR power supply (1 wire on each auxiliary winding) - contact rating 16 A - 250 V A.C.

Connection is identical for resetting the AVR internal protection.



If field weakening is used, provide field forcing.

4.2.3.3 - R450 field forcing



| Applications | B Volt | Time t |
|-----------------------------------|---------|----------|
| Guaranteed voltage build-up | 12 (1A) | 1 - 2 s |
| Parallel operation, de-energized | 12 (1A) | 1 - 2 s |
| Parallel operation, at standstill | 12 (1A) | 5 - 10 s |
| Frequency starting | 12 (1A) | 5 - 10 s |
| Sustained voltage on overload | 12 (1A) | 5 - 10 s |

| | | |
|-----------------------------|------------------------------|-----------------------|
| LEROY-SOMER | Installation and maintenance | 4531 en - 2012.03 / e |
| R 450 AVRs | | |

4.3 - Electrical faults

| Fault | Action | Measurements | Check/Cause |
|--|--|---|--|
| No voltage at no load on start-up | Connect a new battery of 4 to 12 V to terminals F- and F+, respecting the polarity, for 2 to 3 seconds | The alternator builds up and its voltage is still correct when the battery is removed | - Lack of residual magnetism |
| | | The alternator builds up but its voltage does not reach the rated value when the battery is removed | - Check the connection of the voltage reference to the AVR - Faulty diodes - Armature short-circuit |
| | | The alternator builds up but its voltage disappears when the battery is removed | - Faulty AVR - Field windings disconnected - Revolving field coil open circuit. Check the resistance |
| Voltage too low | Check the drive speed | Correct speed | - Check the AVR connections and settings (AVR faulty) - Field windings short-circuited - Rotating diodes burnt out - Revolving field coil short-circuited - Check the resistance |
| | | Speed too low | Increase the drive speed (Do not touch the AVR voltage pot. (P1) before running at the correct speed) |
| Voltage too high | Adjust AVR voltage potentiometer | Adjustment ineffective | - Faulty AVR - 1 faulty diode |
| Voltage oscillations | Adjust AVR stability potentiometer | If no effect: try normal/fast recovery modes | - Check the speed: possibility of cyclic irregularity - Loose connections - Faulty AVR - Speed too low when on load (or U/F knee-point set too high) |
| Voltage correct at no load and too low when on load (*) | Run at no load and check the voltage between F+ and F- on the AVR | Voltage between F+ and F- AREP/PMG < 10 V | - Check the speed (or U/F knee-point set too high) |
| | | Voltage between F+ and F- AREP/PMG > 15 V | - Faulty rotating diodes - Short-circuit in the revolving field coil. Check the resistance - Faulty exciter armature |
| (*) Caution: For single-phase operation, check that the sensing wires coming from the AVR are correctly connected to the operating terminals. | | | |
| Voltage disappears during operation (**) | Check the AVR, the surge suppressor, the rotating diodes, and replace any defective components | The voltage does not return to the rated value | - Exciter winding open circuit - Faulty exciter armature - Faulty AVR - Revolving field coil open circuit or short-circuited - Overload (see LED) |
| (**) Caution: Internal protection may be activated (overload, open circuit, short-circuit) | | | |



Caution: After operational testing or troubleshooting, replace all access panels or covers.

5 - SPARE PARTS

5.1 - Designation

| Description | Type | Code |
|-------------------------|-------|----------------|
| Voltage regulator (AVR) | R 450 | AEM 110 RE 031 |

5.2 - Technical support service

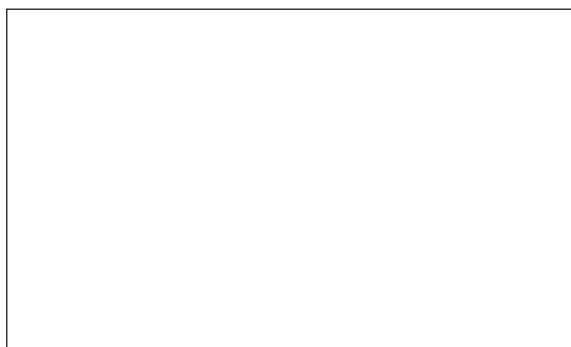
Our technical support service will be pleased to provide any additional information you may require.

When ordering spare parts, you should indicate the AVR type and code number.

Address your enquiry to your usual contact.

Our extensive network of service centres can dispatch the necessary parts without delay.
To ensure correct operation and the safety of our machines, we recommend the use of original manufacturer spare parts.
In the event of failure to comply with this advice, the manufacturer cannot be held responsible for any damage.

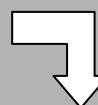
R 450
AVRs



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9.3. Appendix C - Common spare parts

GenPARTS

**R340U***Rental Power***VOLVO
TAD941GE****ENGINE**


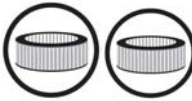



| | | |
|--------------------------|-----------|-----|
| Radiator filler cap | 330051142 | X 1 |
| Radiator pressure cap | 330052078 | X 1 |
| Thermostat | 330051467 | X 1 |
| Thermostat seal | 330051539 | X 1 |
| Fan belt | 330051419 | X 1 |
| Rocker cover seal | 330051468 | X 1 |
| Water temperature sensor | 330051466 | X 1 |
| Oil pressure sensor | 330051465 | X 1 |
| Alternator belt | 330051418 | X 1 |

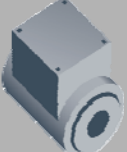
GENLUB

| | | |
|---------|-----------|-----|
| x 25 L | 330910094 | X 1 |
| x 208 L | 330910095 | |

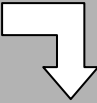
GENCOOL

| | | |
|---------|-----------|-----|
| x 20 L | 330910098 | X 1 |
| x 60 L | 330910099 | |
| x 210 L | 330910100 | |

| | | |
|---|-----------------------|-----|
|  | 330560243 | X 1 |
|  | 330570109 + 330570110 | X 1 |
|  | 330510015 + 330560617 | X 1 |
|  | 330560551 | X 2 |
|  | 330560634 | X 1 |



LEROY-SOMER
LSA462VL12



| | | | |
|-------------------|--------------|-----------|-----|
| ALTERNATOR | Diode bridge | 330410126 | X 1 |
| | Varistor | 330410109 | X 1 |

| | |
|------|---|
| Note | For all technical assistance or spare part requests, contact your nearest SDMO agent. |
|------|---|

9.4. Appendix D - List of John Deere - Volvo and Perkins fault codes

| SPN | CID | SID | PID | PPID | FMI | John Deere | Volvo | Perkins | Description | Comment |
|-----|-----|-----|-----|------|-----|------------|-------|---------|---|--|
| 28 | | | | | | | | | Throttle #3 Position | |
| | | | | | 3 | | | | Throttle Voltage high, short to V+ | Short to V+ |
| | | | | | 4 | | | | Throttle Voltage low, short to V- | Short to V- |
| 29 | | | | | | | | | Throttle #2 Position | |
| | | | | | 3 | | | | Throttle Voltage high, short to V+ | Short to V+ |
| | | | | | 4 | | | | Throttle Voltage low, short to V- | Short to V- |
| | | | | | 14 | | | | Throttle voltage out of range | |
| 84 | | | | | | | | | Vehicle speed | |
| | | | | | 2 | | | | Vehicle invalid or missing | Not possible with Genset application |
| | | | | | 31 | | | | Vehicle speed mismatch | |
| 91 | 91 | | 91 | 132 | | | | | Accelerator pedal position | FMI not determined for all VOLVO's |
| | | | | | 3 | | | | Throttle Voltage high, short to V+ | Not possible with genset application, codes declared by the CAN J1587 for VOLVO. |
| | | | | | 4 | | | | Throttle Voltage low, short to V- | |
| | | | | | 7 | | | | Throttle calibration invalid | |
| | | | | | 8 | | | | PWM throttle abnormal pulse width | |
| | | | | | 9 | | | | Throttle invalid (CAN value) | |
| | | | | | 10 | | | | Throttle voltage out of range low | |
| | | | | | 13 | | | | Throttle calibration aborted | |
| | | | | | 14 | | | | Throttle voltage out of range | |
| 94 | | | 94 | | | | | | Fuel rail pressure sensor | |
| | | | | | 1 | | | | Fuel supply pressure extremely low | |
| | | | | | 3 | | | | Fuel rail pressure input voltage high | Short to V+ |
| | | | | | 4 | | | | Fuel rail pressure input voltage low | Short to V- |
| | | | | | 5 | | | | Fuel rail pressure sensor open circuit | |
| | | | | | 10 | | | | Fuel rail pressure lost detected | |
| | | | | | 13 | | | | Fuel rail pressure higher than expected | |
| | | | | | 16 | | | | Fuel supply pressure moderately high | |
| | | | | | 17 | | | | Fuel rail pressure not developed | |
| | | | | | 18 | | | | Fuel supply pressure moderately low | |
| 97 | | | 97 | | | | | | Water in fuel sensor | |
| | | | | | 0 | | | | Water in fuel continuously detected | |
| | | | | | 3 | | | | Water in fuel input voltage high | Short to V+ |
| | | | | | 4 | | | | Water in fuel input voltage low | Short to V- |
| | | | | | 16 | | | | Water in fuel detected | |
| | | | | | 31 | | | | Water in fuel detected | |
| 98 | | | 98 | | | | | | Oil level sensor | |
| | | | | | 1 | | | | Oil level value below normal | |
| | | | | | 3 | | | | Oil level sensor input voltage high | Short to V+ |
| | | | | | 4 | | | | Oil level sensor input voltage low | Short to V- |
| | | | | | 5 | | | | Oil level sensor open circuit | |

| SPN | CID | SID | PID | PPID | FMI | John Deere | Volvo | Perkins | Description | Comment |
|-----|-----|-----|-----|------|-----|------------|-------|---------|--|-------------|
| 100 | 100 | | 100 | | | | | | Oil pressure sensor | |
| | | | | | 1 | | | | Engine oil pressure extremely low | |
| | | | | | 3 | | | | Oil pressure sensor input voltage high | Short to V+ |
| | | | | | 4 | | | | Oil pressure sensor input voltage low | Short to V- |
| | | | | | 5 | | | | Oil pressure sensor open circuit | |
| | | | | | 17 | | | | Engine oil pressure low | |
| | | | | | 18 | | | | Engine oil pressure moderately low | |
| | | | | | 31 | | | | Oil pressure detected, motor stopped | |
| 102 | 273 | | 102 | | | | | | Manifold air pressure sensor | |
| | | | | | 0 | | | | Manifold air pressure above normal | |
| | | | | | 1 | | | | Manifold air pressure below normal | |
| | | | | | 2 | | | | Incoherent measurement of the oil pressure | |
| | | | | | 3 | | | | Manifold air pressure sensor input voltage high | Short to V+ |
| | | | | | 4 | | | | Manifold air pressure sensor input voltage low | Short to V- |
| | | | | | 15 | | | | Manifold air pressure moderately low | |
| | | | | | 16 | | | | Manifold air pressure low | |
| 103 | | | | | | | | | Turbo speed sensor | |
| | | | | | 0 | | | | Turbo speed too high | |
| | | | | | 5 | | | | Turbo speed sensor circuit open | |
| | | | | | 6 | | | | Sensor shorted to earth | Short to V- |
| | | | | | 8 | | | | Speed signal invalid | |
| | | | | | 31 | | | | Intermittent problem with speed information | |
| 105 | | | 105 | | | | | | Manifold air temperature sensor | |
| | | | | | 0 | | | | Manifold air temperature extremely high | |
| | | | | | 3 | | | | Manifold air temperature sensor input voltage high | |
| | | | | | 4 | | | | Manifold air temperature sensor input voltage low | |
| | | | | | 5 | | | | Manifold air temperature sensor open circuit | |
| | | | | | 15 | | | | Air temperature very high. | |
| | | | | | 16 | | | | Manifold air temperature moderately high | |
| 106 | | | 106 | | | | | | Air inlet pressure sensor | |
| | | | | | 0 | | | | Air inlet pressure above normal | |
| | | | | | 3 | | | | Air inlet pressure sensor input voltage high | |
| | | | | | 5 | | | | Air inlet pressure sensor open circuit | |
| 107 | | | 107 | | | | | | Air filter differential pressure sensor | |
| | | | | | 0 | | | | Air filter restriction high | |
| | | | | | 3 | | | | Air filter differential pressure sensor input voltage high | |
| | | | | | 4 | | | | Air filter differential pressure sensor input voltage low | |
| | | | | | 5 | | | | Air filter differential pressure sensor open circuit | |
| | | | | | 31 | | | | Air filter restriction high | |

| SPN | CID | SID | PID | PPID | FMI | John Deere | Volvo | Perkins | Description | Comment |
|-----|-----|-----|-----|------|-----|------------|-------|---------|--|--------------------------------------|
| 108 | 274 | | 108 | | | | | | Barometric pressure sensor | Not use with EDC III and EMS2 |
| | | | | | 2 | | | | Air pressure invalid | |
| | | | | | 3 | | | | High barometric pressure sensor short to high | |
| | | | | | 4 | | | | High barometric pressure sensor short to low | |
| | | | | | 17 | | | | High barometric pressure | ECM option, sensor not connected |
| 110 | 110 | | 110 | | | | | | Coolant temperature sensor | |
| | | | | | 0 | | | | Coolant temperature extremely high | |
| | | | | | 3 | | | | Coolant temperature sensor input voltage high | |
| | | | | | 4 | | | | Coolant temperature sensor input voltage low | |
| | | | | | 5 | | | | Coolant temperature sensor open circuit | |
| | | | | | 15 | | | | Coolant temperature high least severe | |
| | | | | | 16 | | | | Coolant temperature moderately high | |
| | | | | | 17 | | | | Water temperature very low | |
| | | | | | 31 | | | | Coolant temperature high | |
| 111 | | | 111 | | | | | | Coolant level sensor | |
| | | | | | 0 | | | | Engine coolant level low | |
| | | | | | 1 | | | | Engine coolant level low | |
| | | | | | 3 | | | | Coolant level sensor input voltage high | |
| | | | | | 4 | | | | Coolant level sensor input voltage low | |
| 153 | | | 153 | | | | | | Crankcase pressure sensor | |
| | | | | | 0 | | | | Value above normal | |
| | | | | | 3 | | | | Crankcase pressure sensor input voltage high | |
| | | | | | 5 | | | | Crankcase pressure sensor open circuit | |
| 157 | | | | | | | | | Fuel pressure sensor in the common rail | |
| | | | | | 1 | | | | Fuel pressure too low | |
| | | | | | 3 | | | | Input voltage of the pressure sensor high | Short to V+ |
| | | | | | 4 | | | | Input voltage of the pressure sensor low | Short to V- |
| | | | | | 10 | | | | Loss of fuel pressure detected | |
| | | | | | 16 | | | | Fuel pressure moderately high | |
| | | | | | 17 | | | | Fuel ramp pressure not reached | |
| | | | | | 18 | | | | Oil pressure moderately low | |
| 158 | | | 158 | | | | | | Battery voltage sensor | |
| | | | | | 1 | | | | Voltage above normal | |
| | | | | | 17 | | | | ECU power down error | |
| 160 | | | | | | | | | Wheel speed sensor | |
| | | | | | 2 | | | | Wheel speed input noise | |
| 164 | | 164 | | | | | | | Injection pressure control | |
| 168 | 168 | | | | | | | | Electrical system voltage | |
| | | | | | 2 | | | | Electrical system voltage low | |

| SPN | CID | SID | PID | PPID | FMI | John Deere | Volvo | Perkins | Description | Comment |
|-----|-----|-----|-----|------|-----|------------|-------|---------|---|---|
| 172 | 172 | | 172 | | | | | | Ambient air temperature sensor | Inlet air temperature sensor for PERKINS |
| | | | | | 3 | | | | Ambient air temperature sensor input voltage high | Inlet air temperature sensor input voltage high |
| | | | | | 4 | | | | Ambient air temperature sensor input voltage low | Inlet air temperature sensor input voltage low |
| | | | | | 5 | | | | Ambient air temperature sensor open circuit | |
| | | | | | 15 | | | | | High Inlet air temperature alarm-warning |
| | | | | | 16 | | | | | High Inlet air temperature alarm-action alert |
| 174 | 174 | | | | | | | | Fuel temperature sensor | |
| | | | | | 0 | | | | Fuel temperature high most severe | |
| | | | | | 3 | | | | Fuel temperature sensor input voltage high | |
| | | | | | 4 | | | | Fuel temperature sensor input voltage low | |
| | | | | | 15 | | | | Fuel temperature high | |
| | | | | | 16 | | | | Fuel temperature moderately high | |
| | | | | | 31 | | | | Fuel temperature sensor faulty | |
| 175 | | | 175 | | | | | | Oil temperature sensor | |
| | | | | | 0 | | | | Oil temperature extremely high | |
| | | | | | 3 | | | | Oil temperature sensor input voltage high | |
| | | | | | 4 | | | | Oil temperature sensor input voltage low | |
| | | | | | 5 | | | | Oil temperature sensor open circuit | |
| 177 | | | | | | | | | Transmission oil temperature sensor | |
| | | | | | 9 | | | | Transmission oil temperature invalid | Not possible with Genset application |
| 189 | | | | | | | | | Rated engine speed | |
| | | | | | 0 | | | | Engine speed de rated | |
| | | | | | 31 | | | | Engine speed de rated | |
| 190 | 190 | | 190 | | | | | | Engine speed sensor | |
| | | | | | 0 | | | | Overspeed extreme | |
| | | | | | 2 | | | | Engine speed sensor data intermittent | |
| | | | | | 9 | | | | Engine speed sensor abnormal update | |
| | | | | | 11 | | | | Engine speed sensor signal lost | |
| | | | | | 12 | | | | Engine speed sensor signal lost | |
| | | | | | 15 | | | | Overspeed | |
| | | | | | 16 | | | | Overspeed moderate | |
| 228 | 261 | | | | | | | | Speed sensor calibration | |
| | | | | | 13 | | | | Engine timing abnormal calibration | |
| 252 | 252 | | | | | | | | Software | |
| | | | | | 11 | | | | Incorrect engine software | |
| 234 | 253 | | | | | | | | Check system parameters | |
| | | | | | 2 | | | | Incorrect parameters | |
| 281 | 281 | | | | | | | | Action alert output status | |
| | | | | | 3 | | | | Action alert output open/short to B+ | |
| | | | | | 4 | | | | Action alert output short to ground | |
| | | | | | 5 | | | | Action alert output open circuit | |

| SPN | CID | SID | PID | PPID | FMI | John Deere | Volvo | Perkins | Description | Comment |
|-----|-----|-----|-----|------|-----|------------|-------|---------|---|--------------------------------------|
| 282 | 282 | | | | | | | | Overspeed output status | |
| | | | | | 3 | | | | Overspeed output open/short to B+ | |
| | | | | | 4 | | | | Overspeed output short to ground | |
| 285 | 285 | | | | | | | | Coolant temperature output status | |
| | | | | | 3 | | | | Coolant temperature lamp open/short to B+ | |
| | | | | | 4 | | | | Coolant temperature lamp short to ground | |
| 286 | 286 | | | | | | | | Oil pressure output status | |
| | | | | | 3 | | | | Oil pressure output open/short to B+ | |
| | | | | | 4 | | | | Oil pressure output short to ground | |
| | | | | | 5 | | | | Oil pressure output open circuit | |
| 323 | 323 | | | | | | | | Shutdown output status | |
| | | | | | 3 | | | | Shutdown output open/short to B+ | |
| | | | | | 4 | | | | Shutdown output short to ground | |
| | | | | | 5 | | | | Shutdown output open circuit | |
| 324 | 324 | | | | | | | | Warning output status | |
| | | | | | 3 | | | | Warning output open/short to B+ | |
| | | | | | 4 | | | | Warning output short to ground | |
| | | | | | 5 | | | | Warning output open circuit | |
| 412 | | | | | | | | | Temperature sensor in the EGR valve. | |
| | | | | | 0 | | | | Temperature in the EGR extremely high | |
| | | | | | 3 | | | | Input voltage of the temperature sensor high | Short to V+ |
| | | | | | 4 | | | | Input voltage of the temperature sensor low | Short to V- |
| | | | | | 15 | | | | Temperature in the EGR high | |
| | | | | | 16 | | | | Temperature in the EGR moderately high | |
| 443 | 443 | | | | | | | | ENGINE RUN output status | |
| | | | | | 3 | | | | Engine run output open/short to B+ | |
| | | | | | 4 | | | | Engine run output short to B- | |
| 523 | | | | | | | | | Gear selection | |
| | | | | | 9 | | | | Gear selection invalid | Not possible with Genset application |
| 608 | | 250 | | | | | | | Data link faulty J1587 Start/Stop redundancy / J1939 communication bus | |
| 608 | | | | 132 | | | | | Redundancy of the accelerator | |
| 608 | | | | 98 | | | | | Redundancy of the Stop/start information | |
| 611 | | | | | | | | | Injector wiring status | |
| | | | | | 3 | | | | Injector wiring shorted to power source | |
| | | | | | 4 | | | | Injector wiring shorted to ground | |
| 620 | 262 | 232 | | | | | | | 5 Volt sensor power supply | FMI not informed by VOLVO |
| | | | | | 3 | | | | Sensor power supply open/short to B+ | |
| | | | | | 4 | | | | Sensor power supply short to ground | |

| SPN | CID | SID | PID | PPID | FMI | John Deere | Volvo | Perkins | Description | Comment |
|-----|-----|-----|-----|------|-----|------------|-------|---------|--|--|
| 626 | | | 45 | | | | | | Start enable device (intake heater and ether) | |
| | | | | | 3 | | | | Start enable device output short to B+ | Not used, the control panel is in charge of managing the start enable device |
| | | | | | 4 | | | | Start enable device output short to ground | |
| | | | | | 5 | | | | Start enable device output open circuit | |
| 627 | | | | | | | | | Power supply | |
| | | | | | 1 | | | | Injector supply voltage problem | For 6125HF070 only |
| | | | | | 4 | | | | ECU unswitched power missing | For 6068HF275 VP44 only |
| | | | | | 18 | | | | Battery voltage below the operating voltage | For John DEERE Tiers III |
| 628 | | 240 | | | | | | | Memory fault in EMS2 | |
| 629 | | 254 | | | | | | | ECU status/controller error | CIU module status |
| | | | | | 2 | | | | RAM cell test failure | |
| | | | | | 8 | | | | CPU watchdog reset test failure | |
| | | | | | 11 | | | | Main and fuelling ASIC test fail | |
| | | | | | 12 | | | | RAM address test failure | |
| | | | | | 13 | | | | Watchdog trip failure | |
| | | | | | 19 | | | | ECU to injection pump communication error | Possible only with 6068HF475 VP44 |
| 630 | | 253 | | | | | | | Data set memory EEPROM | |
| 632 | | | | | | | | | Injection status | |
| | | | | | 2 | | | | Fuel shutoff error | |
| | | | | | 5 | | | | Fuel shutoff non-functional | |
| 636 | | 21 | | | | | | | Pump position sensor/Cam position sensor/Speed sensor CAM | Pump position or CAM position in function of the type of injection |
| | | | | | 2 | | | | Pump position sensor/cam position sensor input noise | |
| | | | | | 3 | | | | Permanent loss of signal | |
| | | | | | 5 | | | | High impedance of the position sensor or circuit open | |
| | | | | | 6 | | | | Sensor short to ground | |
| | | | | | 8 | | | | Pump position sensor/cam position sensor input missing | |
| | | | | | 9 | | | | Not informed by VOLVO | |
| | | | | | 10 | | | | Pump position sensor/cam position sensor input pattern error | |
| 637 | | 22 | | | | | | | Crank position sensor/Speed sensor flywheel | |
| | | | | | 2 | | | | Crank position input noise | |
| | | | | | 3 | | | | Permanent loss of signal | |
| | | | | | 5 | | | | High impedance of the position sensor or open circuit | |
| | | | | | 6 | | | | Sensor short to ground | |
| | | | | | 7 | | | | Crank position/Cam position out of synchronisation | |
| | | | | | 8 | | | | Crank position input missing | |
| | | | | | 9 | | | | Not informed by VOLVO | |
| | | | | | 10 | | | | Crank position sensor input pattern error | |

| SPN | CID | SID | PID | PPID | FMI | John Deere | Volvo | Perkins | Description | Comment |
|-----|-----|-----|-----|------|-----|------------|-------|---------|---|---|
| 639 | 247 | 231 | | | | | | | Communication status | |
| | | | | | 2 | | | | Bus Off error | |
| | | | | | 9 | | | | Passive bus error | |
| | | | | | 11 | | | | Data registers read back failure | |
| | | | | | 12 | | | | Loss of message error | |
| | | | | | 13 | | | | Bus CAN error | |
| 640 | | | | | | | | | Engine shutdown vehicle status | |
| | | | | | 11 | | | | Engine shutdown vehicle request invalid | |
| | | | | | 31 | | | | Engine shutdown vehicle request | |
| 641 | | | | | | | | | Status of the Turbo with variable geometry | |
| | | | | | 4 | | | | Supply voltage of the Turbo actuator low | |
| | | | | | 12 | | | | Error in communication between the ECU and the TGV actuator | |
| | | | | | 13 | | | | Error in position of the TGV | |
| | | | | | 16 | | | | Temperature of the actuator moderately high. | |
| 647 | | | | | | | | | Fan supply | |
| | | | | | 3 | | | | Short circuit to earth | |
| | | | | | 5 | | | | Open circuit | |
| 651 | 1 | 1 | 651 | | | | | | Cylinder #1 injector status | |
| | | | | | 0 | | | | Injector outside specifications | Recalibration of the injectors required |
| | | | | | 1 | | | | Injector outside specifications | Recalibration of the injectors required |
| | | | | | 2 | | | | Short circuit high side to B+ | |
| | | | | | 3 | | | | Short circuit high side to low side or low side to B+ | |
| | | | | | 4 | | | | Short circuit high or low side to ground | |
| | | | | | 5 | | | | Cylinder #1 circuit open | |
| | | | | | 6 | | | | Cylinder #1 circuit shorted | |
| | | | | | 7 | | | | Cylinder #1 balancing error/mechanical failure | |
| | | | | | 11 | | | | Cylinder #1 unknown error/mechanical failure | |
| 652 | 2 | 2 | 652 | | | | | | Cylinder #2 injector status | |
| | | | | | 0 | | | | Injector outside the specifications | Recalibration of the injectors required |
| | | | | | 1 | | | | Injector outside the specifications | Recalibration of the injectors required |
| | | | | | 2 | | | | Short circuit high side to B+ | |
| | | | | | 3 | | | | Short circuit high side to low side or low side to B+ | |
| | | | | | 4 | | | | Short circuit high or low side to ground | |
| | | | | | 5 | | | | Cylinder #2 circuit open | |
| | | | | | 6 | | | | Cylinder #2 circuit shorted | |
| | | | | | 7 | | | | Cylinder #2 balancing error/mechanical failure | |
| | | | | | 11 | | | | Cylinder #2 unknown error/mechanical failure | |

| SPN | CID | SID | PID | PPID | FMI | John Deere | Volvo | Perkins | Description | Comment |
|-----|-----|-----|-----|------|-----|------------|-------|---------|---|---|
| 653 | 3 | 3 | 653 | | | | | | Cylinder #3 injector status | |
| | | | | | 0 | | | | Injector outside the specifications | Recalibration of the injectors required |
| | | | | | 1 | | | | Injector outside the specifications | Recalibration of the injectors required |
| | | | | | 2 | | | | Short circuit high side to B+ | |
| | | | | | 3 | | | | Short circuit high side to low side or low side to B+ | |
| | | | | | 4 | | | | Short circuit high or low side to ground | |
| | | | | | 5 | | | | Cylinder #3 circuit open | |
| | | | | | 6 | | | | Cylinder #3 circuit shorted | |
| | | | | | 7 | | | | Cylinder #3 balancing error/mechanical failure | |
| | | | | | 11 | | | | Cylinder #3 unknown error/mechanical failure | |
| 654 | 4 | 4 | 654 | | | | | | Cylinder #4 injector status | |
| | | | | | 0 | | | | Injector outside the specifications | Recalibration of the injectors required |
| | | | | | 1 | | | | Injector outside the specifications | Recalibration of the injectors required |
| | | | | | 2 | | | | Short circuit high side to B+ | |
| | | | | | 3 | | | | Short circuit high side to low side or low side to B+ | |
| | | | | | 4 | | | | Short circuit high or low side to ground | |
| | | | | | 5 | | | | Cylinder #4 circuit open | |
| | | | | | 6 | | | | Cylinder #4 circuit shorted | |
| | | | | | 7 | | | | Cylinder #4 balancing error/mechanical failure | |
| | | | | | 11 | | | | Cylinder #4 unknown error/mechanical failure | |
| 655 | 5 | 5 | 655 | | | | | | Cylinder #5 injector status | |
| | | | | | 0 | | | | Injector outside the specifications | Recalibration of the injectors required |
| | | | | | 1 | | | | Injector outside the specifications | Recalibration of the injectors required |
| | | | | | 2 | | | | Short circuit high side to B+ | |
| | | | | | 3 | | | | Short circuit high side to low side or low side to B+ | |
| | | | | | 4 | | | | Short circuit high or low side to ground | |
| | | | | | 5 | | | | Cylinder #5 circuit open | |
| | | | | | 6 | | | | Cylinder #5 circuit shorted | |
| | | | | | 7 | | | | Cylinder #5 balancing error/mechanical failure | |
| | | | | | 11 | | | | Cylinder #5 unknown error/mechanical failure | |

| SPN | CID | SID | PID | PPID | FMI | John Deere | Volvo | Perkins | Description | Comment |
|-----|-----|-----|-----|------|-----|------------|-------|---------|--|---|
| 656 | 6 | 6 | 656 | | | | | | Cylinder #6 injector status | |
| | | | | | 0 | | | | Injector outside the specifications | Recalibration of the injectors required |
| | | | | | 1 | | | | Injector outside the specifications | Recalibration of the injectors required |
| | | | | | 2 | | | | Short circuit high side to B+ | |
| | | | | | 3 | | | | Short circuit high side to low side or low side to B+ | |
| | | | | | 4 | | | | Short circuit high or low side to ground | |
| | | | | | 5 | | | | Cylinder #6 circuit open | |
| | | | | | 6 | | | | Cylinder #6 circuit shorted | |
| | | | | | 7 | | | | Cylinder #6 balancing error/mechanical failure | |
| | | | | | 11 | | | | Cylinder #6 unknown error/mechanical failure | |
| 676 | | 39 | | | | | | | Glow plug relay status | |
| | | | | | 3 | | | | Glow plug relay voltage high | |
| | | | | | 5 | | | | Glow plug relay voltage low | |
| 677 | | 39 | | 3 | | | | | Start relay status | |
| | | | | | 3 | | | | Start relay control short circuit to high | |
| | | | | | 4 | | | | Start relay control short circuit low | |
| | | | | | 5 | | | | Start relay control open circuit | |
| 678 | 41 | | | | | | | | 8 Volt power supply | |
| | | | | | 3 | | | | ACM 8 Volt DC supply open/short to B+ | |
| | | | | | 4 | | | | ACM 8 Volt DC supply open/short to ground | |
| 679 | | 42 | | | | | | | Regulation sensor of the injection pressure control | |
| 723 | 342 | | | | | | | | Secondary speed sensor | |
| | | | | | 2 | | | | Secondary engine speed sensor data intermittent | |
| | | | | | 11 | | | | Secondary engine speed sensor loss of signal | |
| | | | | | 12 | | | | Loss of signal/sensor failure | |
| 729 | | 70 | | | | | | | Inlet air heater signal/Preheat detection | |
| | | | | | 3 | | | | Inlet air heater signal high | |
| | | | | | 5 | | | | Inlet air heater signal low | |
| 810 | | | | | | | | | Vehicle speed | |
| | | | | | 2 | | | | Calculated vehicle speed input noise | Not possible with Genset application |
| 861 | 861 | | | | | | | | Diagnostic output status | |
| | | | | | 3 | | | | Diagnostic output open/short to B+ | |
| | | | | | 4 | | | | Diagnostic output short to ground | |
| 898 | | | | | | | | | CAN throttle status | |
| | | | | | 9 | | | | Speed value invalid or missing | |
| 970 | | | | 6 | | | | | Auxiliary engine shutdown switch status EMS | |
| | | | | | 2 | | | | Auxiliary engine shutdown switch signal invalid | Not used |
| | | | | | 31 | | | | Auxiliary engine shutdown switch active | |
| 971 | | | | | | | | | External engine de rate switch status | |
| | | | | | 31 | | | | External engine de rate switch active | Not used |

| SPN | CID | SID | PID | PPID | FMI | John Deere | Volvo | Perkins | Description | Comment |
|------|-----|-----|-----|------|-----|------------|-------|---------|--|--------------------------------------|
| 1069 | | | | | | | | | Tire size status | |
| | | | | | 2 | | | | Tire size error | Not possible with Genset application |
| | | | | | 9 | | | | Tire size invalid | |
| | | | | | 31 | | | | Tire size error | |
| 1075 | | | | | | | | | Feed pump of the fuel circuit | |
| | | | | | 5 | | | | High impedance at the terminals of the pump or open circuit | |
| | | | | | 6 | | | | Pump coil short to ground | |
| | | | | | 12 | | | | Pump defective | |
| 1076 | | | | | | | | | Fuel Injection pump status | |
| | | | | | 0 | | | | Pump control valve closure too long | Injection DE10 |
| | | | | | 1 | | | | Pump control valve closure too short | Injection DE10 |
| | | | | | 2 | | | | Pump detected defect | Injection VP44 |
| | | | | | 3 | | | | Pump solenoid current high | Injection DE10 |
| | | | | | 5 | | | | Pump solenoid circuit open | Injection DE10 |
| | | | | | 6 | | | | Pump solenoid circuit severely shorted | Injection DE10 |
| | | | | | 7 | | | | Pump control valve closure not detected | Injection DE10 |
| | | | | | 10 | | | | Pump solenoid circuit moderately shorted | Injection DE10 |
| | | | | | 13 | | | | Pump current decay time invalid | Injection DE10 |
| 1077 | | | | | | | | | Fuel injection pump controller status | |
| | | | | | 7 | | | | Attempting to fuel without command | |
| | | | | | 11 | | | | Pump supply voltage out of range | |
| | | | | | 12 | | | | Pump self test error | |
| | | | | | 19 | | | | Pump detected communication error | |
| | | | | | 31 | | | | Pump initiated engine protection | |
| 1078 | | | | | | | | | ECU/Pump timing status | |
| | | | | | 7 | | | | ECU/Pump timing moderately out of synchronisation | |
| | | | | | 11 | | | | ECU/Pump timing speed out of synchronisation | |
| | | | | | 31 | | | | ECU/Pump timing extremely out of synchronisation | |
| 1079 | | 232 | | | | | | | Sensor supply voltage (+5 Volt) | Analog throttle reference |
| | | | | | 3 | | | | Sensor supply voltage high | > 5,5 Volt |
| | | | | | 4 | | | | Sensor supply voltage low | < 4,44 Volt |
| 1080 | | 211 | | | | | | | Sensor supply voltage (Oil pressure, Coolant temp, fuel pressure)/+5V sensor supply 2 | |
| | | | | | 3 | | | | Sensor supply voltage high | > 5,5 Volt |
| | | | | | 4 | | | | Sensor supply voltage low | < 4,40 Volt |
| 1109 | | | | | | | | | Engine/ECU status | |
| | | | | | 31 | | | | Engine shutdown warning | |
| 1110 | | | | | | | | | Engine status | |
| | | | | | 31 | | | | Engine shutdown | |
| 1111 | 268 | | | | | | | | Check parameters | |
| | | | | | 2 | | | | Programmed parameter fault | |
| 1136 | | | | 55 | | | | | ECU Temperature | |
| | | | | | 0 | | | | ECU temperature extremely high | |
| | | | | | 16 | | | | ECU temperature moderately high | |

| SPN | CID | SID | PID | PPID | FMI | John Deere | Volvo | Perkins | Description | Comment |
|------|-----|-----|------|------|-----|------------|-------|---------|--|---|
| 1172 | | | | | | | | | Input temperature of the TGV compressor | |
| | | | | | 3 | | | | Input voltage of the temperature sensor high | Short to V+ |
| | | | | | 4 | | | | Input voltage of the temperature sensor low | Short to V- |
| 1180 | | | | | | | | | Input temperature of the TGV turbine | |
| | | | | | 0 | | | | Turbine temperature extremely high | Short to V+ |
| | | | | | 16 | | | | Turbine temperature moderately high | Short to V- |
| 1184 | | | 173 | | | | | | Exhaust gas temperature sensor | |
| 1239 | | | | 96 | | | | | Status of the pressure system of the common rail | |
| 1347 | | | | | | | | | Pump control valve status | Pump control valve #1 status for 6081HF070 |
| | | | | | 3 | | | | Pump control valve current high | |
| | | | | | 5 | | | | Pump control valve error/mismatch | |
| | | | | | 7 | | | | Fuel rail pressure control error | |
| | | | | | 10 | | | | Pump control valve fuel flow not detected | |
| 1348 | | | | | | | | | Pump control valve #2 status | Only for 6081HF070 |
| | | | | | 5 | | | | Pump control valve #2 error/mismatch | |
| | | | | | 10 | | | | Pump control valve #2 fuel flow not detected | |
| 1485 | | | 1485 | 5 | | | | | Pump power relay status | ECU main relay of VOLVO EMS/EDC |
| | | | | | 2 | | | | Pump power relay fault | |
| | | | | | 3 | | | | | ECU main relay short circuit high |
| 1568 | | | | | | | | | Torque curve selection | |
| | | | | | 2 | | | | Torque curve selection invalid | |
| | | | | | 4 | | | | Torque curve input voltage high | |
| | | | | | 9 | | | | Torque curve selection missing | |
| SPN | CID | SID | PID | PPID | FMI | John Deere | Volvo | Perkins | Description | Comment |
| 1569 | | | | | | | | | Fuel supply status | |
| | | | | | 31 | | | | Fuel de rate | |
| 1639 | | | | | | | | | Fan speed | |
| | | | | | 1 | | | | Fan speed zero or absent | |
| | | | | | 2 | | | | Fan speed signal erratic | |
| | | | | | 16 | | | | Fan speed more than 300 rpm above its setpoint for at least 180s | |
| | | | | | 18 | | | | Fan speed more than 300 rpm below its setpoint for at least 180s | |
| 2000 | | | | | | | | | ECU status | |
| | | | | | 6 | | | | Vehicle ID missing | |
| | | | | | 13 | | | | Security violation | |

| SPN | CID | SID | PID | PPID | FMI | John Deere | Volvo | Perkins | Description | Comment |
|--------|-----|-----|-----|------|-----|------------|-------|---------|--|--------------------|
| 2630 | | | | | | | | | Air temperature at the air cooler outlet | |
| | | | | | 0 | | | | Air temperature extremely high | |
| | | | | | 3 | | | | Sensor input voltage high | Short to V+ |
| | | | | | 4 | | | | Sensor input voltage low | Short to V- |
| | | | | | 15 | | | | Air temperature high | |
| | | | | | 16 | | | | Air temperature moderately high | |
| 2659 | | | | | | | | | Flow level of the EGR valve | |
| | | | | | 2 | | | | Calculated EGR flow not valid | |
| | | | | | 15 | | | | Calculated EGR flow rather high | |
| | | | | | 17 | | | | Calculated EGR flow rather low | |
| 2790 | | | | | | | | | Air temperature at turbo compressor outlet | |
| | | | | | 16 | | | | Temperature at compressor outlet moderately high | |
| 2791 | | | | 19 | | | | | Statuses of the EGR valve | |
| | | | | | 2 | | | | Valve position signal not valid | |
| | | | | | 3 | | | | Input voltage of the position sensor high | Short to V+ |
| | | | | | 4 | | | | Input voltage of the position sensor low | Short to V- |
| | | | | | 7 | | | | Inability of the EGR valve to reach the expected position | |
| | | | | | 13 | | | | The EGR valve is out of calibration | |
| | | | | | 31 | | | | Error in position of the EGR valve | |
| 2795 | | | | | | | | | Position of TGV actuator | |
| | | | | | 7 | | | | The actuator does not respond or is not in the expected position | |
| 3509 | | | | | | | | | Common supply voltage of the sensors, output #1 | |
| | | | | | 3 | | | | Supply voltage of the sensor too high | Exceeding +5 volts |
| | | | | | | | | | Supply voltage of the sensor shorted to ground | |
| 3510 | | | | | | | | | Common supply voltage of the sensors, output #2 | |
| | | | | | 3 | | | | Supply voltage of the sensor too high | Exceeding +5 volts |
| | | | | | | | | | Supply voltage of the sensor shorted to ground | |
| 3511 | | | | | | | | | Common supply voltage of the sensors, output #3 | |
| | | | | | 3 | | | | Supply voltage of the sensor too high | Exceeding +5 volts |
| | | | | | | | | | Supply voltage of the sensor shorted to ground | |
| 3512 | | | | | | | | | Common supply voltage of the sensors, output #4 | |
| | | | | | 3 | | | | Supply voltage of the sensor too high | Exceeding +5 volts |
| | | | | | | | | | Supply voltage of the sensor shorted to ground | |
| 3513 | | | | | | | | | Common supply voltage of the sensors, output #5 | |
| | | | | | 3 | | | | Supply voltage of the sensor too high | Exceeding +5 volts |
| | | | | | | | | | Supply voltage of the sensor shorted to ground | |
| 520192 | | | | 8 | | | | | Cooling status of the piston | |
| 520194 | | | | 4 | | | | | Status of the starting request input | |
| 520195 | | | | 6 | | | | | Stop request on CIU | |

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FMI and Description

FMI=0—DATA VALID BUT ABOVE NORMAL OPERATIONAL RANGE - MOST SEVERE LEVEL

The signal communicating information is within a defined acceptable and valid range, but the real world condition is above what would be considered normal as determined by the predefined most severe level limits for that particular measure of the real world condition (*Region e* of the signal range definition). Broadcast of data values is continued as normal. Broadcast of data values is continued as normal.

FMI=1—DATA VALID BUT BELOW NORMAL OPERATIONAL RANGE - MOST SEVERE LEVEL

The signal communicating information is within a defined acceptable and valid range, but the real world condition is below what would be considered normal as determined by the predefined least severe level limits for that particular measure of the real world condition (*Region e* of the signal range definition). Broadcast of data values is continued as normal.

FMI=2—DATA ERRATIC, INTERMITTENT OR INCORRECT

Erratic or intermittent data includes all measurements that change at a rate that is not considered possible in the real world condition and must be caused by improper operation of the measuring device or its connection to the module. Broadcast of data value is substituted with the “error indicator” value.

Incorrect data includes any data not received and any data that is exclusive of the situations covered by FMIs 3, 4, 5 and 6. Data may also be considered incorrect if it is inconsistent with other information collected or known about the system.

FMI=3—VOLTAGE ABOVE NORMAL, OR SHORTED TO HIGH SOURCE

- a. A voltage signal, data or otherwise, is above the predefined limits that bound the range (*Region e* of the signal range definition). Broadcast of data value is substituted with the “error indicator” value.
- b. Any signal external to an electronic control module whose voltage remains at a high level when the ECM commands it to low. Broadcast of data value is substituted with the “error indicator” value.

FMI=4—VOLTAGE BELOW NORMAL, OR SHORTED TO LOW SOURCE

- a. A voltage signal, data or otherwise, is below the predefined limits that bound the range (*Region e* of the signal range definition). Broadcast of data value is substituted with the “error indicator” value.
- b. Any signal external to an electronic control module whose voltage remains at a low level when the ECM commands it to high. Broadcast of data value is substituted with the “error indicator” value.

FMI=5—CURRENT BELOW NORMAL OR OPEN CIRCUIT

- a. A current signal, data or otherwise, is below the predefined limits that bound the range (*Region e* of the signal range definition). Broadcast of data value is substituted with the “error indicator” value.
- b. Any signal external to an electronic control module whose current remains off when the ECM commands it on. Broadcast of data value is substituted with the “error indicator” value.

FMI=6—CURRENT ABOVE NORMAL OR GROUNDED CIRCUIT

- a. A current signal, data or otherwise, is above the predefined limits that bound the range. (*Region e* of the signal range definition). Broadcast of data value is substituted with the “error indicator” value.
- b. Any signal external to an electronic control module whose current remains on when the ECM commands it off. Broadcast of data value is substituted with the “error indicator” value.

FMI=7—MECHANICAL SYSTEM NOT RESPONDING OR OUT OF ADJUSTMENT

Any fault that is detected as the result of an improper mechanical adjustment or an improper response or action of a mechanical system that, with a reasonable confidence level, is not caused by an electronic or electrical system failure. This type of fault may or may be directly associated with the value of general broadcast information.

FMI=8—ABNORMAL FREQUENCY OR PULSE WIDTH OR PERIOD

To be considered in cases of FMI 4 and 5. Any frequency or PWM signal that is outside the predefined limits which bound the signal range for frequency or duty cycle (outside *Region b* or the signal definition). Also if the signal is an ECM output, any signal whose frequency or duty cycle is not consistent with the signal which is emitted. Broadcast of data value is substituted with the “error indicator” value.

FMI=9—ABNORMAL UPDATE RATE

Any failure that is detected when receipt of data via the data link or as input from a smart actuator or smart sensor is not at the update rate expected or required by the ECM (outside *Region c* of the signal range definition). Also any error that causes the ECM not to send information at the rate required by the system. This type of fault may or may be directly associated with the value of general broadcast information.

FMI=10—ABNORMAL RATE OF CHANGE

Any data, exclusive of the abnormalities covered by FMI 2, that is considered valid but whose data is changing at a rate that is outside the predefined limits that bound the rate of change for a properly functioning system (outside *Region c* of the signal range definition). Broadcast of data values is continued as normal.



FMI=11—ROOT CAUSE NOT KNOWN

It has been detected that a failure has occurred in a particular subsystem but the exact nature of the fault is not known. Broadcast of data value is substituted with the “error indicator” value.

FMI=12—BAD INTELLIGENT DEVICE OR COMPONENT

Internal diagnostic procedures have determined that the failure is one which requires the replacement of the ECU, used here to mean the packaged unit that includes some microprocessor and its associated components and circuits. It can be assumed that the communications subsystem is not the part that has failed, and the manufacturer has determined that there is no serviceable component smaller than the ECU involved in the failure. Broadcast of data value is substituted with the “error indicator” value if appropriate, as there may or may not be any broadcast involved. This error is to include all internal controller trouble codes that can not be caused by connections or systems external to the controller.

FMI=13—OUT OF CALIBRATION

A failure that can be identified to be the result of not being properly calibrated. This may be the case for a subsystem which can identify that the calibration attempting to be used by the controller is out of date. Or it may be the case that the mechanical subsystem is determined to be out of calibration. This failure mode does not relate to the signal range definition as do many of the FMIs.

FMI=14—SPECIAL INSTRUCTIONS

“Special Instructions” is the FMI to be used when the on-board system can isolate the failure to a small number of choices but not to a single point of failure. When the FMI is used, there is clear necessity for the service technician to take some action to complete the specific diagnosis, and the manufacturer has provided instructions for the completion of that diagnosis. There are two cases where this will be used: 1. for emission-related diagnostics where the particular failure cannot be separated between a sensor out of range and the case where the actual value is at the edge of a diagnostic region, and 2. for the older SPN 611 to 615 where the problem is in determining which of two or more circuits (which may interact) is the one that needs repair.

SPNs 611 through 615 are defined as “System Diagnostic Codes” and are used to identify failures that cannot be tied to a specific field replaceable component. Specific subsystem fault isolation is the goal of any diagnostic system, but for various reasons this cannot always be accomplished. These SPNs allow the manufacturer some flexibility to communicate non-“specific component” diagnostic information. Since SPNs 611-615 use the standard SPN/FMI format it allows the use of standard diagnostic tools, electronic dashboards, satellite systems and other advanced devices that scan Parameter Groups containing the SPN/FMI formats. Because manufacturer defined codes are not desirable in terms of standardization, the use of these codes should only occur when diagnostic information cannot be communicated as a specific component and failure mode.

Possible reasons for using a System Diagnostic Code include:

1. Cost of specific component fault isolation is not justified, or
2. New concepts in Total Vehicle Diagnostics are being developed, or
3. New diagnostic strategies that are not component specific are being developed.

Due to the fact that SPNs 611-615 are manufacturer defined and are not component specific, FMIs 0-13 and 15-31 have little meaning. Therefore, FMI 14, “Special Instructions”, is usually used. The goal is to refer the service personnel to the manufacturer's troubleshooting manual for more information on the particular diagnostic code. This failure mode does not relate to the signal range definition as do many of the FMIs. This type of fault may or may be directly associated with the value of general broadcast information.

FMI=15—DATA VALID BUT ABOVE NORMAL OPERATING RANGE - LEAST SEVERE LEVEL

The signal communicating information is within a defined acceptable and valid range, but the real world condition is above what would be considered normal as determined by the predefined least severe level limits for that particular measure of the real world condition (*Region i* of the signal range definition). Broadcast of data values is continued as normal.

FMI=16—DATA VALID BUT ABOVE NORMAL OPERATING RANGE - MODERATELY SEVERE LEVEL

The signal communicating information is within a defined acceptable and valid range, but the real world condition is above what would be considered normal as determined by the predefined moderately severe level limits for that particular measure of the real world condition (*Region k* of the signal range definition). Broadcast of data values is continued as normal.

FMI=17—DATA VALID BUT BELOW NORMAL OPERATING RANGE - LEAST SEVERE LEVEL

The signal communicating information is within a defined acceptable and valid range, but the real world condition is below what would be considered normal as determined by the predefined least severe level limits for that particular measure of the real world condition (*Region h* of the signal range definition). Broadcast of data values is continued as normal.

FMI=18—DATA VALID BUT BELOW NORMAL OPERATING RANGE - MODERATELY SEVERE LEVEL

The signal communicating information is within a defined acceptable and valid range, but the real world condition is below what would be considered normal as determined by the predefined moderately severe level limits for that particular measure of the real world condition (*Region j* of the signal range definition). Broadcast of data values is continued as normal.

FMI=19—RECEIVED NETWORK DATA IN ERROR

Any failure that is detected when the data received via the network is found substituted with the “error indicator” value (i.e. FE16, see J1939-71). This type of failure is associated with received network data. The component used to measure the real world signal is wired directly to the module sourcing the data to the network and not to the module receiving the data via the network. The FMI is applicable to *Region f* and *g* of the signal range definition. This type of fault may or may be directly associated with the value of general broadcast information.

FMI=20-30—RESERVED FOR SAE ASSIGNMENT**FMI=31—CONDITION EXISTS**

Used to indicate that the condition that is identified by the SPN exists when no more applicable FMI exists or in cases when the reported SPN name spells out the component and a non-standard failure mode. This type of fault may or may be directly associated with the value of general broadcast information. This FMI will mean “not available” when the associated SPN is also “not available” as when the remainder of the packet is filled with binary ones after all data has been transmitted.